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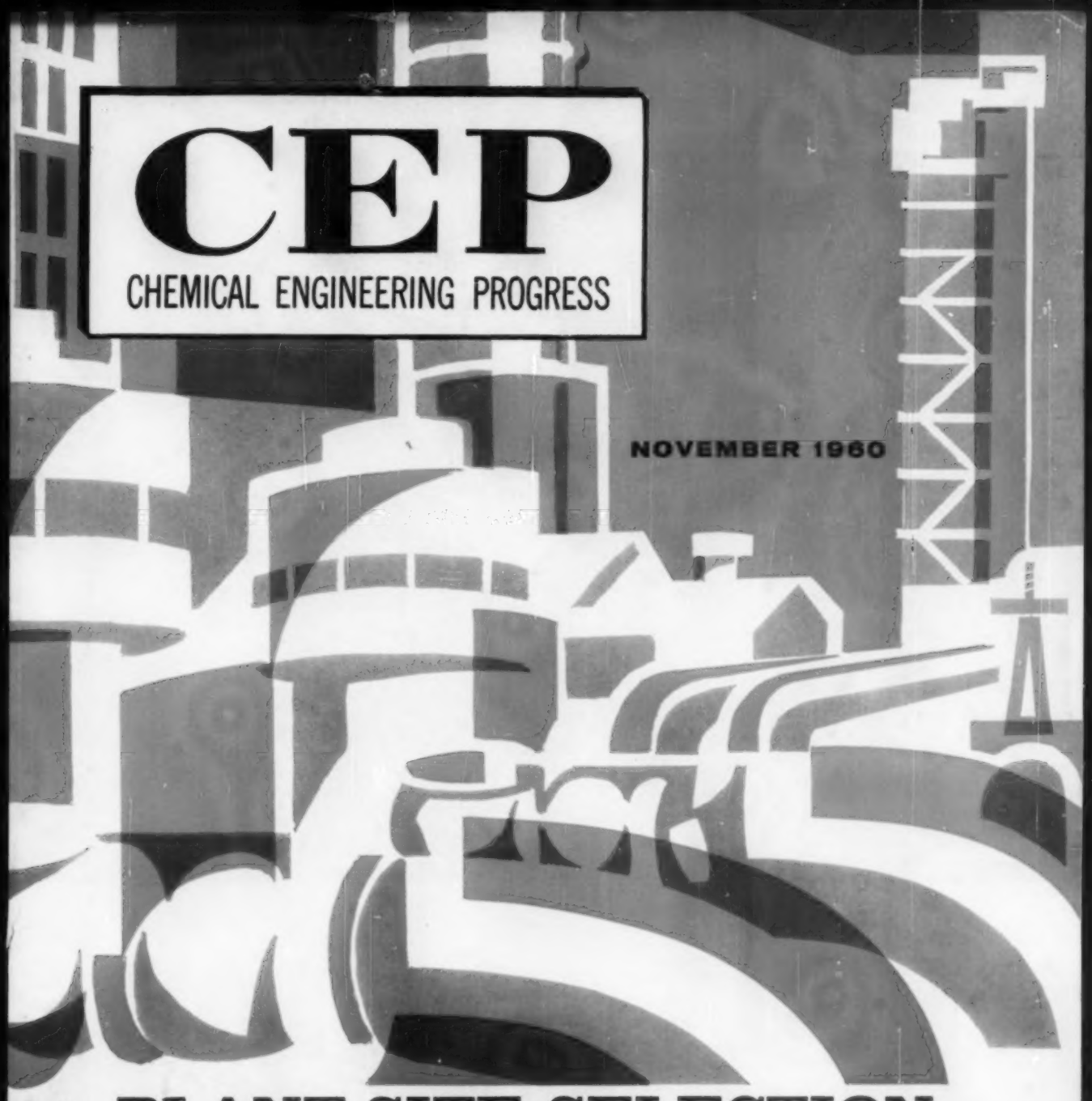
CHEMICAL ENGINEERING PROGRESS

NOVEMBER 1960



PLANT SITE SELECTION page 37

and State-by-State Round-up page 85

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CHEMICAL ENGINEERING PROGRESS

November 1960 Volume 56, No. 11

Published monthly by American Institute of Chemical Engineers. Editorial and Advertising Offices, 25 West 45th Street, New York 36, N. Y. Communications should be sent to the Editor. Statements and opinions in *Chemical Engineering Progress* are those of the contributors, and the American Institute of Chemical Engineers assumes no responsibility for them. Subscriptions: U. S. and possessions, one year $6.00; two years $10.00; three years $14.00 (2-yr. and 3-yr. rates apply to U. S. and possessions only.) Canada, $6.50; Pan American Union, $7.50; Other Foreign, $8.00. Single copies of *Chemical Engineering Progress* older than one year cost $1.00 a copy; others are 75 cents. Second class mailing privileges authorized at New York, New York. Copyright 1960 by American Institute of Chemical Engineers. Member of Audit Bureau of Circulations. *Chemical Engineering Progress* is indexed regularly by Engineering Index, Inc.

Postmaster: Please send form 3579 to Chemical Engineering Progress, 25 West 45th Street, New York 36, N. Y.

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.... in this issue

(Continued on page 5)

WEATHER
CLEAR OVERHEAD
NO MIST

The York Times

WEDNESDAY, NOVEMBER 9, 1960

LANDSLIDE VICTORY

FOR MR. DEMISTER®

OUTSTANDING CANDIDATE WINS ON CLEAN SEPARATION POLICY

This month of elections again finds Mr. Demister, the Otto H. York symbol for improved process equipment performance, the leader among mist eliminators and entrainment separators.

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Efficiency — York Demisters are extremely efficient — over 99.9% — accounted for by over 100 square feet of surface per cubic foot of separator volume.

The leader among mist eliminators and entrainment separators.

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In a gasoline plant, rator vessels were l exit lines from the sorbers. Because recovery, the ver ments were rem mister element entrainment sepa stainless steel, cost of $317.00 which showed gal./day of 96 col solution i $2.25/gal. th for in twenty year, the thre This illustr misters in misters wil of distillati rators, kn bers, stean vacuum

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SPECIALISTS IN FLUIDS SEPARATIONS

CEP .... in this issue

(Continued from page 3)

OUT OF FLUIDICS COMES A NEW MATERIAL

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What processes, heretofore held back for lack of a proper material, will you explore first with Nucerite?

For example, if corrosion at high temperatures is a problem, Pfaudler® Nucerite could be the answer, since it resists corrosive vapors at temperatures that would destroy most metals in minutes.

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You are invited to make inquiries on possible applications for it and investigate field testing programs. The above lab test data are detailed in Bulletin 999. Use the coupon, or direct your questions to our Pfaudler Division, Dept. CE-110, Rochester 3, New York.

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book reviews

ION EXCHANGE: A LABORATORY MANUAL, J. E. Salmon & D. K. Hale, Academic Press Inc., N. Y., and Butterworths Scientific Publications, London (1959), vii + 136 pp., illustrated, $5.00

During the past decade, several books on the subject of ion exchange have been published in the U. S., England, France, Germany, Sweden, and Japan. These publications have covered both the theory and technology of ion exchange. Since ion exchange is an accepted member of the family of unit operations in the realm of chemical engineering, and since ion exchange techniques are now a necessary tool of the chemists in the laboratories of industry and academic institutions, a manual that can serve as a guide to the chemist, chemical engineer, or student embarking for the first time upon laboratory studies involving ion exchange techniques serves a worthy purpose.

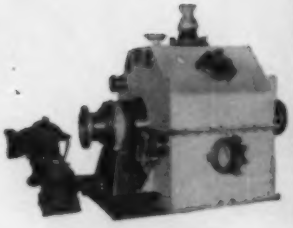
This book by two British research chemists experienced in ion exchange techniques fills this need. Salmon of Battersea College (London) and Hale of the National Chemical Laboratory (London) have prepared this laboratory manual in a very clear style, and have incorporated all the essential details that the uninitiated require.

The manual includes an introduction to the chemistry of ion exchange resins as well as the equilibria and kinetics of ion exchange. Details are given for conducting various typical experiments involving the use of ion exchange techniques in analytical and preparative chemistry, and in purification and recovery processes. The illustrative sketches of laboratory apparatus should prove quite helpful to the unexperienced technician.

Although some of the material contained in the manual is available in other books, the inclusion of such information will be worthwhile to the technician. One might quarrel with the authors as to the manner in which several exchange reactions are expressed, and as to some details of procedure. However, these points are minor. Since the book is a laboratory manual, and will probably be used very close to the laboratory bench, the reviewer regrets that the paper used was not of a better grade.

All in all, the reviewer feels that *Ion Exchange: A Laboratory Manual* will become a valuable addition to the existing literature on ion exchange.

Reviewed by Robert Kunin, Research Division, Rohm & Haas Co.



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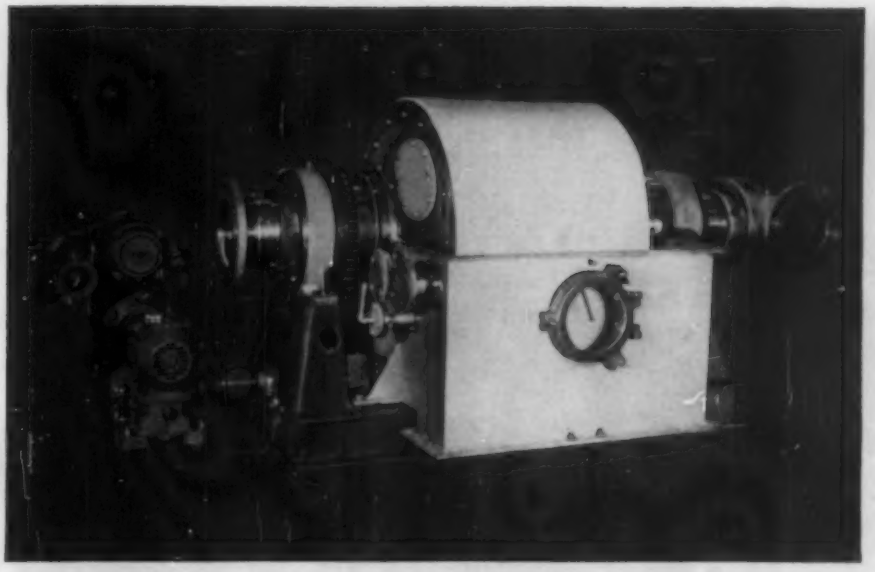

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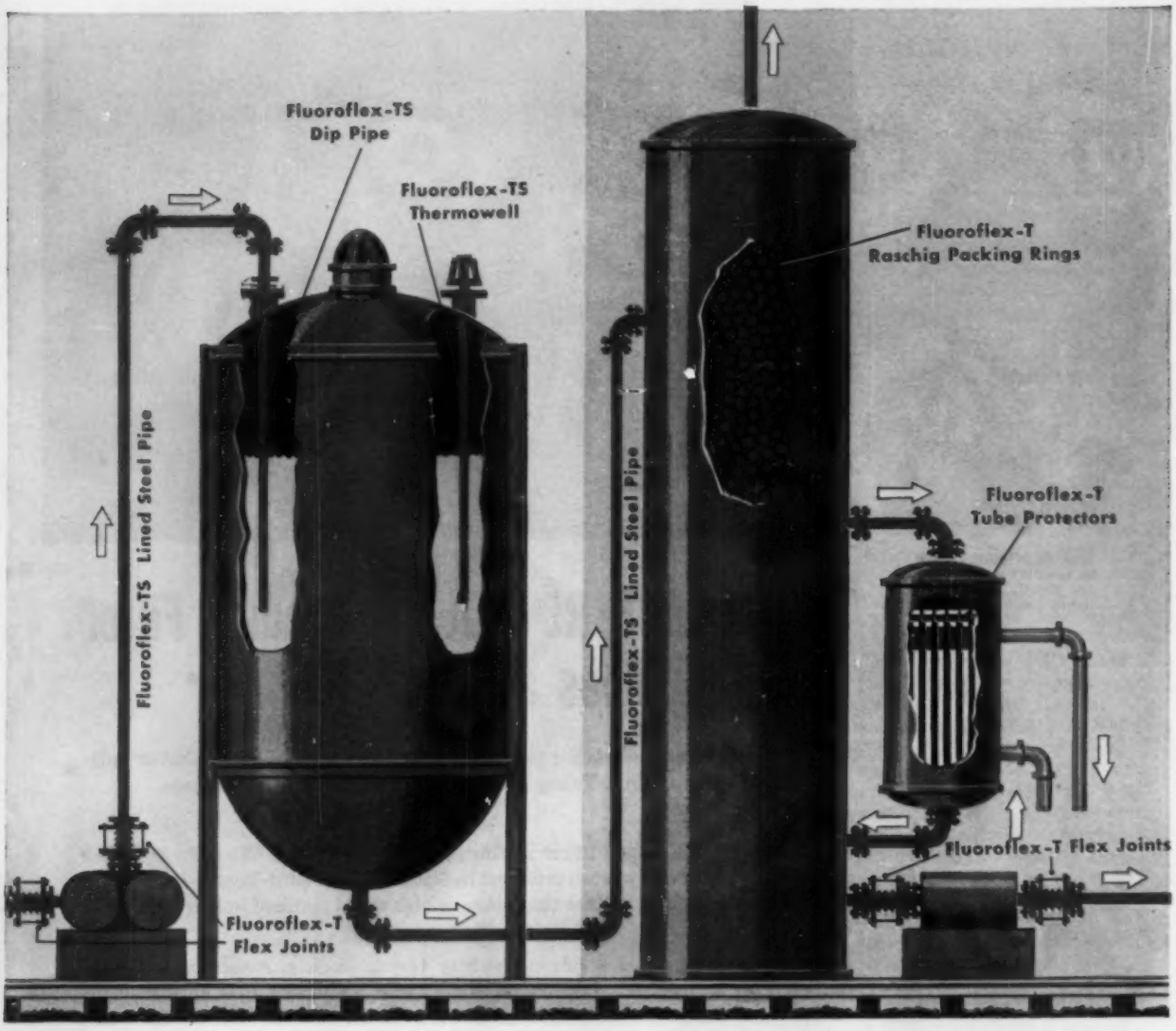

HERE'S WHY corrosion-proof fluid-handling production savings,

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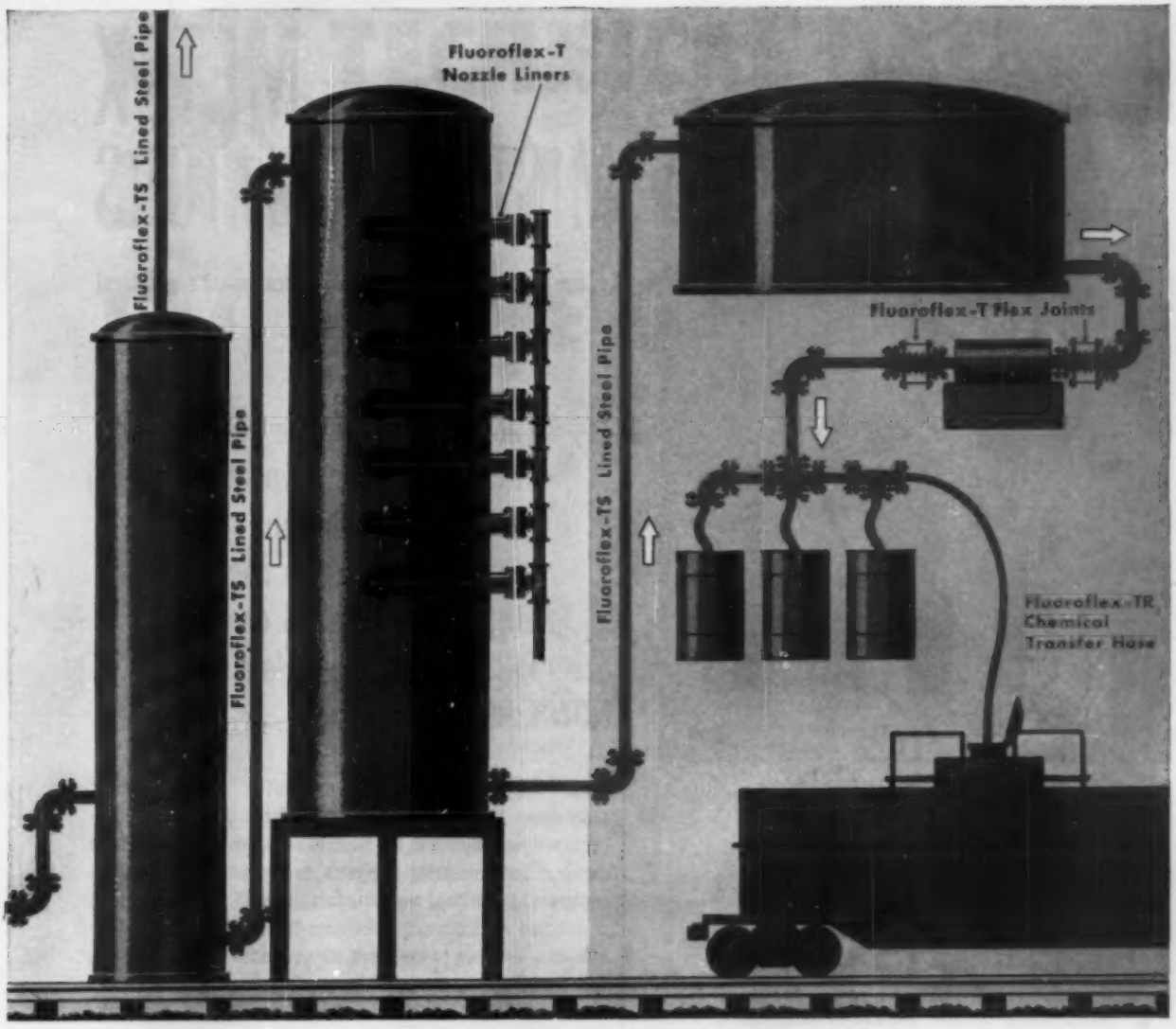

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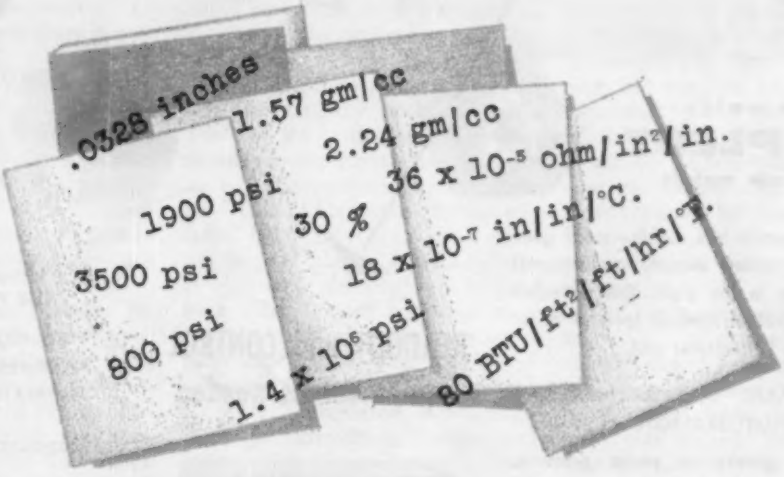
Recently issued data sheets prepared by our Technical Department contain important information about graphite anode properties.



Among the typical physical properties detailed for anodes in various grades and sizes are maximum particle sizes... apparent and real density... porosity... resistivity... rupture... compressive and tensile strength... elasticity... thermal expansion and conductivity.

Typical chemical properties of the anode grades show percentages of ash, sulfur, silicon, iron, calcium, aluminum, vanadium sodium, titanium and other impurities.

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What belongs to me? What belongs to the company?

Perplexing problem of how much information can be carried by an engineer moving from one company to another aired by panel at Tulsa meeting. Question is as much moral as specific. It's not black or white, but includes a large gray area.

"WHO OWNS YOUR KNOWLEDGE? Or the case of, 'Can you take it with you?'" With these words, John J. McKetta, University of Texas, kicked off a spirited panel discussion on the subject of *Professional Conduct* at the Tulsa National Meeting of A.I.Ch.E. The problem boils down to one of how much of your knowledge can you take to the new company when you change employers.

Some of the most valuable resources you have to offer your employer, said McKetta, are these three: 1) The knowledge you possess; 2) Your ability to absorb newfound knowledge; and, 3) Your judgment in using the knowledge to solve company problems. Another of your most valuable is your *integrity*. Judgment is your own, now and forever. But according to some recent court decisions, some of your knowledge belongs *forever* to your employer, especially with regard to trade secrets. Much of the problem may yet hinge upon "What is a trade secret?" McKetta said.

Three of the cases which came under discussion were: Monsanto vs. Miller & Torkelson Co.; National Cylinder Gas vs. nine men of Catalysts & Chemicals; and Allied Chemical vs. Dixon Chemical et al.

Common law recognized

The Miller case is a matter of court record and, being clear-cut, it is doubtful whether it contributes much to a discussion of gray areas in contractual relationships said John Healy, Monsanto V. P. and upcoming president of A.I.Ch.E. While Miller originally signed an employment agreement with the company, upon his return from service in the Armed Forces no new contract was executed, and he left the company in the Fall, 1954. One of his responsibilities entailed being in charge of an electric furnace plant for manufacture of elemental phosphorous. In January, 1956, he was employed as a consultant by a cooperative company and later became director of manufacturing. The company was engaged in research and design study preliminary to design and construction of an electric furnace plant. The court found that Miller deliberately acquired information for future use for over a year prior to resignation. He appropriated over 102 detailed blueprint drawings, cost data, transformer and other design prints. The court found he passed this information over to design and construction firms retained by the cooperative. Information and data were incorporated in the design of the plant in question.

The court ultimately gave Monsanto a permanent injunction against the defendant restraining him from disclosing the company's trade secrets. Even though no contract was signed, the court said that the nature of his employment was such as to subject him to the

common law duty not to reveal any engineering data, design studies, or operating data confided to him while in the employ of the company and which comprised company trade secrets.

Moral test basic

The test of the issue as regards trade secrets is like the test of any issue involving wrongdoing, said Lawrence Coleman, General counsel for Allied Chemical. Which secret belongs to me, which to my boss, is the question. It is a subjective test. You as an individual know better than the employer or even the judge. The only test which is a reasonable one to apply in the broad concept is "Can you sleep at night?" This basically is the test of all morality, he said. An employer's secrets are esoteric and this makes it complex. It is the burden of the employer to establish that it is a secret before the act. You must keep your secret "secret". For instance a company has to fence its plant and sign drawings in and out. If the secret is made public by publication or

McKetta
. . . most valuable is your integrity

carelessness it is no longer a secret. There must be delineation. The whole plant isn't secret. It is "this" which is secret. When a company does these things, it then has the right to expect its secrecy to be respected, said Coleman. In the Allied case, an employee literally stole plans which he submitted to another company as his own. This was a flagrant case of out and out stealing, not a matter of something simply retained in his head.

What is secret?

Of the engineers, 99.9% are trained in the ethical viewpoint of the profession, said Joe Parker, chairman of Catalyst and Chemicals. An engineer learns basics in college and enters industry with his tool sort of blunt. He knows the subject matter and where to find information. He learns more from industry, but he also contributes to industry. In leaving school he is usually handed a contract to sign which may be good, bad or indifferent. This is signed since he needs the job, and usually everything is satisfactory until there is a

Coleman
. . . individual knows better than employer

point of dispute.

My personal experience was to start up in the catalyst manufacturing business from a strictly ethical standpoint said Parker. As a matter of protection I went to a law firm with experience in ethical procedures and practices. They gave me what might be considered a "standard opinion". They said: 1) You are experienced; 2) Competition already exists in the field; 3) No drawings or pictures have been removed; 4) No secret processes or secret materials will be used by you. They said, "You may go into business but you can be sued, right or wrong."

In our case we didn't take process information, but we took people with know-how. This was felt by the parent company, and the natural reaction was a lawsuit. This dragged on and on and was eventually settled by our agreeing to pay a royalty. The question naturally arises as to why we didn't start out and make an agreement in the early phases, said Parker. It would have been better, but it is hard to get together early, for people are too far apart to make a deal at such times.

The problem is what is secret. To the industry maybe everything is, to the individual maybe nothing. The company's advantages should be outlined as secret. We can't have all chemical engineering as secret. We need ideas, said Parker. It would be helpful if the Institute could be the judge between individual and company when the need arises so the area of gray matter can be thrashed out to protect both.

Schools and publications

There is a serious effort to teach something in the engineering schools on ethics and professionalism, said Scott Walker, University of Tulsa. The teachings range from a few lectures to formal courses. The student also picks up ideas by participating in student professional societies. Unfortunately there are shortcomings. The students are generally young, and all are not sufficiently mature to grasp the subtle but important aspects of the subject. The Engineers Council for Professional Development has done much to try to solve the problem. The university can start the educational process. It behooves the individual and his professional society to continue to emphasize further education. Basically, we must be guided by the "Golden Rule".

Publications are on the perimeter, said George Weber, editor of *The Oil and Gas Journal*. Due to events of past years there is a problem in selecting material for publication. We are involved in litigation on an issue where a consultant wrote an article and the material's ownership was challenged by the company. Publications hence have to check the source carefully, and take care that the author plus company are parties to the agreement to publish. It is still necessary to rely on an

Parker
. . . all chem engineering can't be secret

individual's integrity, and even with close screening of articles problems probably will still crop up.

The audience speaks up

What about a situation where a technical service engineer tells you that under certain conditions your product is superior to your competitors? Can you tell this to your customer?

If it were told without the stipulation that it was in confidence, then it's a legitimate sales tool, said Parker. In any event, you should first reaffirm that what you were told was true by making your own tests.

When a contract binds a person "forever", this can be a long, long time.

Walker
. . . must be guided by Golden Rule

The foreclosure of trade secrets is really a matter for the courts to determine as to individual conditions and situations, said Coleman. Actually most courts act on the premise that reasonable restraint is in order. If you are enjoined from practicing in Oshkosh in a certain location for two years, this might be reasonable. Preventing you from practicing in North America for five years might be considered unreasonable. Still there are some situations where "forever" might be reasonable as might the exclusion of a large geographical area. Along this line, said Healy, in the Monsanto case Miller wasn't even enjoined from practicing but simply from disclosing trade secrets.

What is the company liable for in asking a man from another company to come work for it?

The new company is charged with a high degree of responsibility. It shouldn't attempt to hire an employee and urge him to commit a breach of confidence, said Coleman. The subsequent employer is obligated to advise the employee, and not put him in a position where there is "opportunity to sin". The company's liability is as great, if not greater, than the engineer's.

Where does the A.I.Ch.E. stand on the subject?

The Institute's standards for professional conduct are set down in black and white in two documents, said Healy. They are Article VIII, the Code of Ethics, of the Constitution and By-Laws, and the pamphlet "Professional Standards", and everyone should have a copy (if you don't ask us . . . Ed.) There is always the urge and inclination to refine codes so they may become more specific. This may be harmful, for the impression may be left that those specific items that are left out inadvertently are not directly involved, said Healy.

Assume an engineer develops something which he tries to sell management but is turned down. If he leaves and sells his idea to another company and it clicks, what then?

The company in order to enforce secrecy must impress the employee with the emphasis on secrecy, said Coleman. Hence, if they don't like his proposition it's reasonable to assume the facts aren't considered secret by them and he can take them with him. The burden of proof in court, said Healy, is that the company must show harm has been done. It would be hard to prove such harm has been done in a case like this.

If an engineer goes to the literature and gets his basic information and data, is it wrong to keep a copy of the design or report if it merely represents work based on a collection of literature?

Weber
. . . problem in selecting material for publication

If the material and information has been published beforehand, then it is not a crime to keep it. However, if the information has been expanded by company-owned information, then it would be questionable, said Coleman.

Healy
. . . Institute's standards are in black and white

If the legal profession can disbar its members, how about a similar situation for engineers and scientists?

Where everyone is in an integrated group, such as a bar, this is possible, said Coleman, and ideally it should be so for professional societies. Actually, we have such a procedure in A.I.Ch.E to expell a member for misconduct, said Healy. However, it would not keep him from practicing his profession.

In general, said McKetta in summing up the discussion, all of our members recognize the clear cut facts of patents, confidential and secret information, and their obligation to their employers in this regard. Monsanto has had only one case requiring court action since 1933, and Allied only one in its history. There has been much discussion of the gray area which is not clearly defined as to what belongs to the employer and what belongs to the engineer as a tool ot his trade. We've been fortunate in having the companies represented who were involved in actual situations. We all have benefited by exposure to their experiences and from the discussion.

As a summation, said McKetta, I like the broad qualifying phrase mentioned earlier: Can you sleep at night?

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U.S.I. CHEMICAL NEWS

November ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1960

ATTENTION: Holders of U.S.I. Alcohol Catalog

U.S.I. has revised the Government Regulations Supplement to its Ethyl Alcohol Catalog to incorporate A&TTD's latest regulations on the distribution and use of Specially Denatured and Tax-Free Alcohols, which went into effect on July 1, 1960.

The new supplement has also been revised for greater ease of understanding. It is now available to all holders of the Ethyl Alcohol Catalog and others interested upon request on company letterhead. Address Technical Literature Dept., U.S.I. Chemical News, 99 Park Avenue, New York 16, N. Y.

FDA Authorizes DL-Methionine for Dietary Supplements

In the Federal Register of August 4, 1960, the FDA announced that DL-methionine may be included in dietary supplements in amounts up to 200 milligrams per day. This announcement is based on findings that no undue risk to the public health is involved in the use of DL-methionine for this purpose.

Permission has been granted for a period of one year commencing March 6, 1960, or until regulations are issued establishing tolerances for DL-methionine or exemption from the requirement of tolerances, whichever occurs first.

DL-Methionine is an essential, sulfur-bearing amino acid used in dietary supplements along with vitamin preparations. It has also been used as an ingredient in cosmetics and skin applications, and for pharmaceutical and animal feed purposes since 1946.

New Unit Makes Hydrogen From Ammonia on Demand

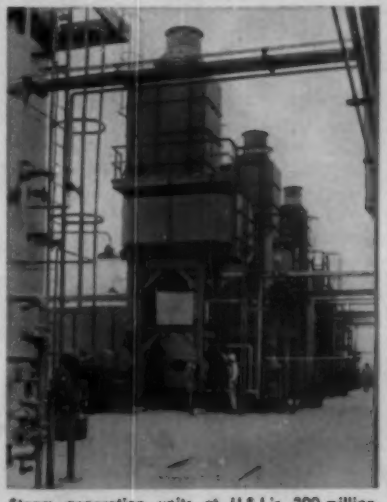
Pure hydrogen generating units with capacities up to 60 million stream cubic feet per year have been developed for small volume users of the gas in operations such as metal treating. The generators are said to yield hydrogen of 99.995% purity which costs less than cylinder gas and no more than hydrogen from electrolytic sources. In addition, it is claimed that the gas is purer than that obtained by electrolytic methods, containing no oxygen or hydrocarbons and less than 50 ppm of nitrogen.

MORE

U.S.I. Doubles Polyethylene Capacity at Houston Plant

New Expansion Makes Company World's Second-Largest Producer of Polyethylene Resins

A new section of U.S.I.'s polyethylene installation at Houston, Texas, is now on-stream. This latest expansion doubles the capacity of the plant, brings total production of PETROTHENE® polyethylene resins to 300 million pounds per year, and establishes U.S.I. as the second-largest producer of polyethylene resins in the world.



Steam generation units at U.S.I.'s 200-million pound polyethylene plant at Houston, Texas.

Rapid Growth Since 1955

The company's first polyethylene facility, with an annual capacity of 25 million pounds, was started up at Tuscola, Illinois, in early 1955. This plant was doubled in 1956 and redoubled in 1957 to a capacity of 100 million pounds per year. Early in 1959, the Houston installation came on-stream, producing 75 million pounds of resin annually (soon increased to 100 million). The expansion just completed brings the Houston plant capacity up to 200 million pounds per year.

Houston Location Convenient

The Houston installation is well situated on the Houston Ship Channel for shipment of resins by all means of transportation. Export shipments are easily made through the city's extensive port facilities. The plant is assured of a plentiful supply of ethylene—the major raw material—from salt dome storage facilities.

Resins are Tailored to Use

Although U.S.I. makes a full line of low and medium density polyethylene resins for all applications, much of its growth in polyethylene has been based on special efforts to develop improved coating and film grade resins. The company pioneered the technique for producing crystal-clear cast film. Within the past six months it has developed and introduced a new

MORE

Product storage silos at U.S.I.'s 200-million-pound polyethylene plant at Houston, Texas.

Great Potential Seen for Pharmaceutical Aerosols

According to a recently published article, packaging and sale of aerosol pharmaceuticals are still way below potential, although these products are among the fastest growing in the aerosol industry. It is claimed that practically all types of topical products and respiratory tract treatments are aerosol potentials. Many systemic drugs also could be administered by aerosol inhalation. Here are some advantages listed for pharmaceutical aerosols:

(1) contents remain sterile.
(2) there is no danger of product contamination during topical application.
(3) spread of infection during application is avoided.
(4) application is fast and easy.
(5) danger of accidental poisoning by ingestion is minimized.
(6) many materials normally injected or taken orally can be inhaled.
(7) packaging costs are low compared to the value of the product.

MORE

CONTINUED *Polyethylene*

produce-bag resin, a new paper coating resin, a new cast film resin and two high-flow blending resins.

Tailor-making resins for specific purposes is one of the distinguishing features of U.S.I. as a polyethylene producer. For example, the company recently developed three new blow-molding resins particularly suited to bottles for drugs, cosmetics and chemical specialties. In all, the company markets some 80 resins today, each varying somewhat in melt index, density, strength, clarity, gloss, slip, stiffness and other properities.

View of U.S.I.'s 200-million-pound polyethylene plant at Houston, Texas.

CONTINUED *Aerosols*

The article suggests that if the pharmaceutical industry engaged in a concentrated promotional effort, aimed at doctors, pharmacists and the general public, its aerosol business could achieve a dollar volume in excess of $200 million within the next decade. Medical science would also gain, from the development of better and easier methods of administering therapeutic medications.

CONTINUED *Hydrogen Generator*

According to the report, the new unit separates ammonia into its components by heating in the presence of a ferric oxide catalyst. The resultant gas mixture is then compressed, undissociated ammonia is removed by absorption, and the resultant gas stream is refrigerated, in stages down to −345 F. at 50 mm Hg abs. Nitrogen liquifies and is separated from the hydrogen, which is then analyzed for purity and stored for use.

Columbium-Uranium Alloys Make Nuclear Fuels that Perform in 1,600°F. Range

Recent research work has revealed that columbium alloyed with 20% by weight of uranium metal yields a nuclear fuel which maintains high tensile strength and hardness in the 1,600°F. temperature range. This makes the alloy an excellent fuel for high-temperature, high-efficiency compact nuclear reactors such as gas-cooled units, it is claimed. The best metallic fuel elements used currently are said to be unable to withstand temperatures above 1,200°F.

New Chemicals Listed In New Monthly Index

INDEX CHEMICUS, a new monthly index to new chemicals, can now be purchased on a subscription basis. The publication is said to report and index new chemicals within 30 days after their appearance in the primary journals.

INDEX CHEMICUS, contains listings of chemical names, structural diagrams, molecular formulas, and complete bibliographical information for each compound. Indexes are accumulated quarterly and yearly.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

A soluble form of cholesterol is now available commercially. Is a 24-mol ethylene oxide ether containing 25% pure cholesterol (derived from lanolin). Claimed convenient, economical for topical preparations, including clear aqueous and alcoholic vehicles and emulsions. **No. 1650**

New radiochemical catalog now available lists over 400 radiolabeled compounds. Also describes high intensity beta and gamma sources, reference sources, radioactive standards, radio-chemical kits. **No. 1651**

Twelve enzymes now offered are described in new booklet. Include α-, β-, γ-chymotrypsin, α-chymotrypsinogen, deoxyribonuclease, hyaluronidase, hyaluronic acid, peroxidase, ribonuclease, trypsin, trypsinogen, uricase. **No. 1652**

Ethyl acetate is subject of new technical data bulletin. Covers three grades—commercial 85-88% ester, 95-98% ester, 99% ester (acetic ether). Data include specifications, properties, shipping information, uses. **No. 1653**

18 Pre-formulated reagent test sets, said to speed up procedures and cut costs in clinical laboratories, now on market. Procedures included. Sets described in leaflet available. **No. 1654**

Lupin alkaloids and related compounds are now being offered in research quantities for physiological evaluations. Compounds include lupinine, d-oxylupinine, d-α-isolupinine, d-α-isolupinine perchlorate, d-lupinine perchlorate, d-hydroxylupinine, 3-hydroxy sparteine. **No. 1655**

Radioisotopes in science and industry is discussed in new AEC report being sold. Summarizes Isotopes Development Program to accelerate peaceful use of radiation and reactor by-products in agriculture, medicine, chemistry, etc. **No. 1656**

Glycerine in toilet goods is subject of group of talks made by toilet goods experts and now available in reprint form. Talks were given at 1960 symposium of Glycerine Producers Assn. **No. 1657**

Two new surface tensiometers, one manual and one semi-automatic, now offered for measuring surface and interfacial tension by fast, accurate ring method. Suggested for oils, surfactants, cosmetics, drugs, insecticides, other. **No. 1658**

Specially formulated emulsifier for drugs and cosmetics is described in new brochure. Material is blend of cetyl and stearyl alcohols and higher alcohol sulfates. Formulations, clinical details, bibliography are included. **No. 1659**

Washington scope

Engineers to gather in the nation's capital

WASHINGTON WILL BE ALIVE with Chemical Engineers in a couple of weeks. The American Institute of Chemical Engineers holds its 53rd Annual Meeting here at the Statler Hilton Hotel on December 4, 5, 6 and 7th.

In addition to the outstanding technical program arranged by DeWitt Myatt and his committee, there is much else you will want to do and see while you are here. If you haven't visited the nation's capital in a long time you'll be surprised at its obvious growth. Lots of new privately owned office buildings are just being completed and many more are just starting. The suburban areas too are bursting. This is normal for most American big cities today, but in the midst of Washington's 2,000,000 inhabitants there are some new things that are unusual.

The new State Department Building is a tremendous affair. By its majestic size it impresses one with the present day importance of international affairs. In addition, the Federal Government has these important buildings currently under construction here:

New Senate Office Building	$26,000,000
Federal Office Building 6	10,950,500
Federal Office Building 9 (to house Civil Service Commission)	13,192,000
Smithsonian Institution	23,738,680
CIA Building	33,287,600
Capitol Extension	21,000,000
New House Office Building	66,000,000

Washington offers an excellent opportunity for those of you who live inland to enjoy the world's finest seafood. In addition to the many famous restaurants (world-famous Trader Vic is putting a restaurant in the Statler Hilton), and the many places of entertainment (National Theatre has "Hero", a musical with Tom Poston, billed for December 4, 5, 6, 7th), there is much for the more historical minded chemical engineer and his family to see. Almost everyone has seen in pictures or in reality such things as the Washington Monument, the Jefferson and Lincoln Memorials, and the National Capitol. But there are less widely publicized equally interesting points of interest.

For the religious, there is the great National Cathedral (Episcopalian), started a half-century ago and still building, and the recently completed beautiful National Shrine of the Immaculate Conception (Roman Catholic).

For the business executive there are the national headquarters of:

- Manufacturing Chemists Association
- National Association of Manufacturers
- National Planning Association
- U. S. Chamber of Commerce

The man with labor interests should not fail to see some of the beautiful new, as well as some old, national and international union headquarters buildings of which there are 55 in the area. Typical of these are:

- American Federation of Labor & Congress of Industrial Organizations
- International Brotherhood of Electrical Workers
- International Union of Operating Engineers
- International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers Union
- International Hod Carriers Building & Common Laborers Union

In addition, there is the United Mine Workers Building made famous by John L. Lewis.

Those who are strongly oriented toward organizations will want to see the just-dedicated headquarters of the American Chemical Society. The National Headquarters of the National Society of Professional Engineers, the National Association for the Advancement of Science, and the American Institute of Architects are all located

within walking distance of the Statler-Hilton.

If your interest is in education there are 21 institutions of higher learning, as well as national headquarters of the National Education Association. The principal universities are:

American University
Catholic University
George Washington University
Georgetown University
University of Maryland

If you are interested in research you can have a field day—over half of all the research conducted in the U.S.A. is administered from Washington. In addition a lot of it is actually done here.

There are over 35,000 engineers (4,523 registered Professional Engineers in the District of Columbia) and scientists who earn their living here. Washington has the greatest number of technologists per capita in the country—probably in the western world. Private organizations conducting research and development number 144 and employ 10,000 technologists. These men utilize 249 libraries totaling over 25 million volumes, including the famous, and world's largest, Library of Congress, for which a new building has recently been authorized.

There are just too many Government laboratories to list in this column. But there is work in every branch of science constantly under way, so be sure to ask if you are interested in some specific area of research. The National Bureau of Standards, the Naval Research Laboratories, the Naval Ordnance Laboratory and the National Institutes of Health are well-known favorites. The National Aeronautics and Space Agency is building a new facility in nearby Greenbelt, Maryland.

There are several important widely-known organizations here which do much for research and technology:

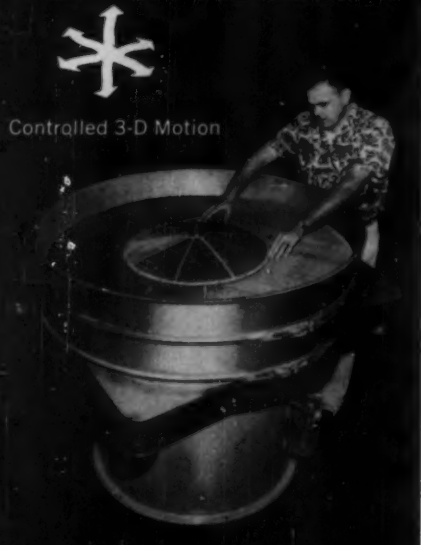
Brookings Institution
Carnegie Institute of Washington
National Academy of Sciences and National Research Council
National Science Foundation
Resources of the Future
Smithsonian Institution
U. S. Patent Office
National Meteorological Experiment Center

Washington, all-in-all, is a great place to visit. It's important, it's beautiful, and it offers so much worth seeing. The Nation's Capital will welcome you with open arms.

—J. L. GILLMAN, JR.

De Laval tackles process problems

...economically!



Getting all shook up on one horsepower!

It speaks well for the design and operating efficiency of the De Laval Syncro-Matic that its high-capacity 3-dimensional screening action is all accomplished with a *one* horsepower motor. The energy you pay for is concentrated on your product rather than being dissipated by attacking your floor beams. Tune the controls for gentle sifting or for turbulent, high-throughput classification and you can count on quiet, practically vibration-free performance.

Unlike ordinary screens based on eccentric weights, the action of the De Laval Syncro-Matic is positive and controllable—and unaffected by variations in screen loadings. Use of the three calibrated motion controls lets you achieve optimum screening action. Capacity improvements in the range of 50 to 300% over conventional equipment have been reported.

Mounted screens (single, double or triple) are drum-tight—easily and quickly replaceable. Choose between plain or stainless steel construction. Your product – wet or dry, fine or coarse, crystal-hard or delicately soft – will be more efficiently classified, more rapidly processed—or both.

For Further Information Write To Dept. EP-4

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CENTRIFUGES
PLATE HEAT EXCHANGERS
VIBRATING SCREENS
COMPLETE PROCESSES

For more information, circle No. 73

After the "Clarifier" and the "Nozzle-Bowl" ...what?...This!

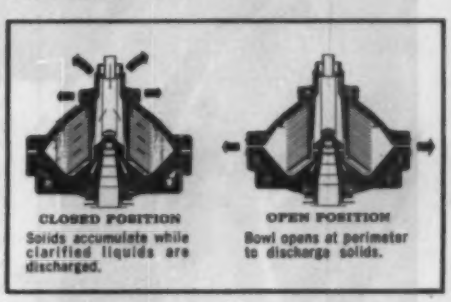
Problem A: An immiscible liquid mixture is to be centrifugally separated. An unwanted heavy sediment is also present.

Problem B: A solids suspension is to be continuously separated from a liquid (or liquid mixture), concentrated and reclaimed.

Complication: The solids are so plentiful they fill a "clarifier" bowl too quickly. Or the feed rate is too low to warrant a continuous-discharge nozzle-bowl centrifuge. Or the solids are too large for nozzle discharge. Or you want to wash the solids before discharge. Or...

Solution: Such complications dissolve into routine operating procedure when one of De Laval's new PX self-opening separators is used. While the liquid mixture is being efficiently separated and discharged, the solids accumulate in the ample bowl wall space. At a predetermined solids build-up, the bowl is opened at the perimeter, and pffft!... out go the solids to a discharge cover. The De Laval "PX" never misses an RPM!

Applications possibilities are legion in the processing of foods, fats, oils and chemicals...especially for De Laval's unusually compact, more economically operated models. Be the first in your group with the facts! Write for the "De Laval PX Self-Opening Separator" leaflet!



CLOSED POSITION
Solids accumulate while clarified liquids are discharged.

OPEN POSITION
Bowl opens at perimeter to discharge solids.

AN INCH, AN OUNCE, AN ERG...

Small differences add up to significant considerations when choosing equipment. The economy of power in our Synchro-Matic screen separators has its **real** meaning in operating performance. Inches add to many cubic feet or yards saved with our remarkably compact Plate Heat Exchangers. Special disc design in our Centrifuges makes a larger capacity possible for a given frame size. Such not-so-small differences add up to many years of operating payoff!

Fred Wheelwright, Industrial Manager

Laminar flow licked at Reynolds no. 180!

Memory being what it is, process engineers often forget that a 2100 Reynolds number is the borderline for turbulent flow *only* for flow in smooth tubes. In our De Laval Plate Heat Exchangers, the plate corrugations completely frustrate laminar flow and many operate with high transfer efficiency at Reynolds numbers in the range of 180.

Then there's the fact that heat transfer coefficients are normally 600-750 and often over 900 Btu/hr-ft²-°F. And also that for equal heat transfer coefficients, De Laval Plate Heat Exchangers require a lower pressure drop than shell-and-tubes.

With operating efficiencies that shell-and-tubes can't match – with multi-compartmentation easily arranged – with remarkable compactness – and with easily added capacity at any time – De Laval's stainless steel Plate Heat Exchangers are gaining steadily on the cheaper (but more costly to install and operate) shell-and-tubes. Join the "modern design" group. Send for booklet!

letters to the editor

New concepts wanted

To the Editor:

This is to express my appreciation for your editorial in the May issue of *Chemical Engineering Progress* in which you reviewed and emphasized the conclusions of the National Science Foundation Conference Committee on Research. I agree wholeheartedly with the suggestion that research efforts should be more venturesome, and that we should encourage presentation and publication of papers of a philosophical nature.

However, when functioning as a symposium chairman, program chairman, or author, I have found considerable resistance to this concept. The solution of boundary-value problems, regardless of whether they bear any useful or apparent relationship to the world, is currently in vogue in most engineering meetings and publications; certain types of routine, if difficult, experimental investigations, such as the measurement of eddy diffusivities, are also O.K. On the other hand, papers presenting the results of exploratory experimentation, or new ideas or new interpretations of old work, are out of fashion, and seem to inspire great irritation among the majority of reviewers.

I suspect that papers which present new concepts, new interpretations or new syntheses of ideas are the greatest contributions to the profession. Even if the concepts and ideas are later proven to be wrong, they encourage thinking and reexamination, and inspire still better ideas. Likewise, data of ±50% uncertainty in new fields in which it is not possible to make predictions within 100% are more important than data of ±1% uncertainty in a worked-over field in which the results could have been predicted with a ±5% uncertainty before the work was started. As an example, two papers submitted to me as Program Chairman of a recent meeting, and which I found most exciting, produced several highly indignant responses from reviewers although no constructive or even definitive objections were raised. Although these papers were scheduled for presentation anyway, this type of response is certainly disheartening to authors and potential exploratory researchers.

STUART W. CHURCHILL
Professor,
Univ. of Michigan

What caused the explosion?

To the Editor:

I was quite interested in the article on construction practices for cryogenic equipment which appeared on Page 44 of the May, 1960, issue of *Chemical Engineering Progress*. Of particular interest to us was the paragraph including the statement, "The main problem associated with aluminum alloys are their welding characteristics. Aluminum alloys offer problems from the corrosion standpoint in specific instances, and finely-divided metal may get into the system through repair procedures or original assembly and cause an explosion." Attached is a copy of our booklet entitled "Cryogenic Applications of Alcoa Aluminum" which shows many examples of welded aluminum structures.

With regard to the reported explosion, we would be interested in any and all information you can give us which would amplify the remarks which you made, and would welcome an opportunity to delve further into the situation referred to in your discussion of Mr. Lawrence of USI. That aluminum actually ignited is open to question since the ignition temperature even for minus 200 mesh aluminum powder is above the melting point of aluminum. It is difficult to believe that a pipeline designed for service at minus 320°F would not fail mechanically if heated sufficiently to raise the metal temperature above the melting point of aluminum while in service. For this reason it seems likely to me that the example cited was a mechanical failure from maloperation rather than ignition of aluminum.

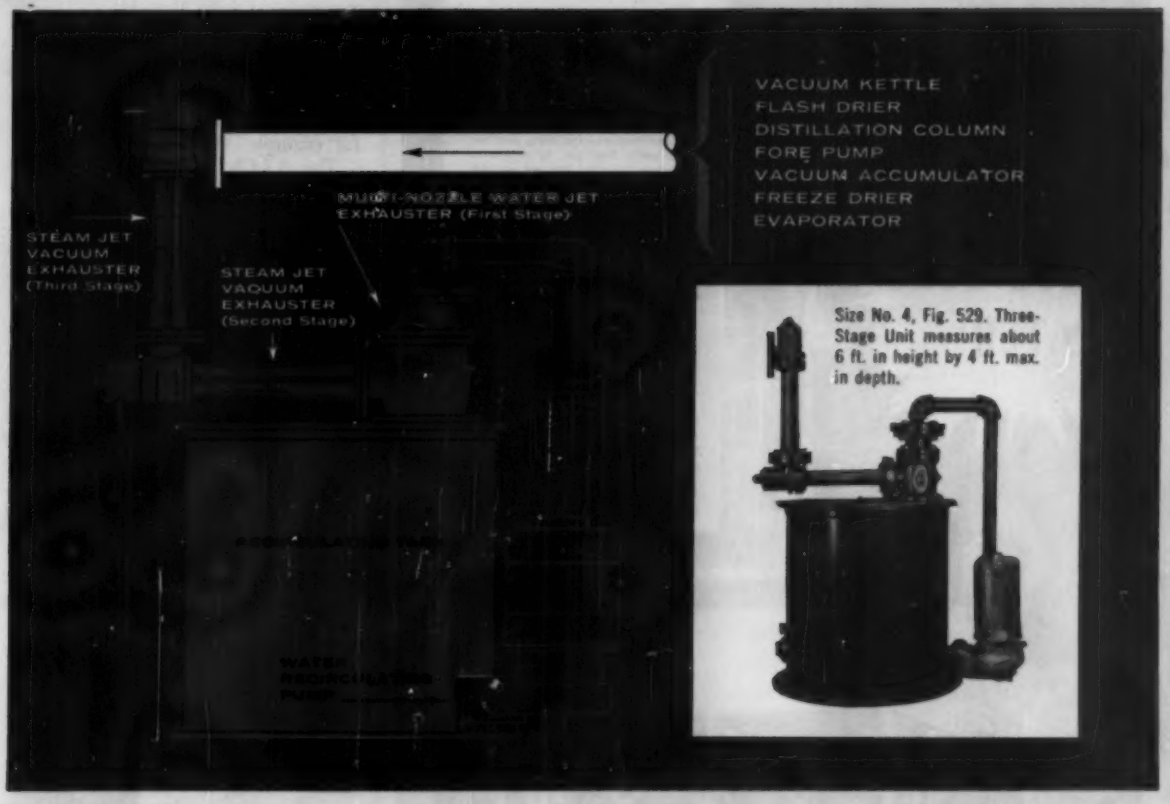
ELLIS D. VERINK, JR.
Aluminum Co. of America

Further details available

To the Editor:

This is to reply to the letter (above) concerning my remarks at the Safety in Air Separation Plants panel of the A.I.Ch.E. You will appreciate that in such a ten minute discussion it is difficult to do full justice to all aspects of materials of construction. The approach used, therefore, was to place each material within a frame of reference using the ASME allowable stress ratings, and to mention the major fabricating advantages and limitations of each material as they would be important to the repair and maintenance of air separation equipment. Although prime equipment manufacturers may be well versed in the welding of aluminum, it would seem likely

continued on page 28



Size No. 4, Fig. 529. Three-Stage Unit measures about 6 ft. in height by 4 ft. max. in depth.

PRODUCE HIGH VACUUM QUICKLY & ECONOMICALLY

with this "Packaged" Hydro-Steam Unit

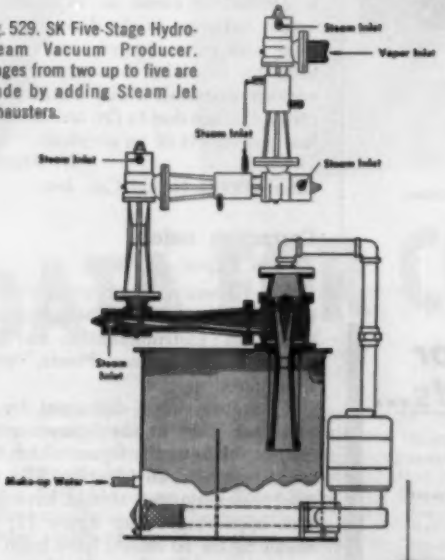


Fig. 529. SK Five-Stage Hydro-Steam Vacuum Producer. Stages from two up to five are made by adding Steam Jet Exhausters.

The unit shown is a "packaged" vacuum producer designed to operate at ground level. Using plant steam and make-up water, it will produce the low suction pressures required for many operations in chemical, food, and petroleum processing plants.

These units are made in a range of sizes in single-stage, two, three, four, and five-stage types. Depending upon size and type, units in this line will provide suction pressures ranging from atmosphere to 1.5 in. Hg abs (single-stage) up to 0.25 mm Hg abs to 25 microns Hg abs (five-stage).

SK "Packaged" Vacuum Producers offer specific, worthwhile advantages. They are simple in construction, are self-contained, compact, require little head room or floor space, are easily installed. Unlike mechanical vacuum producers, contamination presents no problems. They are operated easily, produce vacuum quickly, are economic, can be used intermittently or continuously as desired.

New Bulletin 5H-HS gives complete details on application, construction, operation including suction pressures provided and data on steam consumption and make-up water required. Send for a copy.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES. Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin G-1.

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For more information, turn to Data Service card, circle No. 132

letters to the editor

from page 26

that maintenance welders in chemical plants might find aluminum unfamiliar and more difficult to handle than for example, stainless steel.

The A.I.Ch.E. meeting was principally concerned with safety problems in the operation of air separation plants, and a major share of the time was devoted to the discussion of specific accidents and their causes. It was within this context that the remarks about the hazard of finely divided metal were made. In my reply to Mr. Lawrence, I tried to indicate that the explosion referred to did not occur in a separation plant itself, but in a military missile base during the transferral of oxygen from a storage tank to a truck. For further details, you are referred to a paper "Propellant Handling Transfer and Storage" by J. W. Schultz of Pan American at the Patrick Air Force Base. The paper was presented at the American Rocket Societies Flight Testing Conference March 23-25, 1959, held at Daytona Beach.

The author indicates that finely divided aluminum or flux left in the pipe after repairing might have initiated the explosion which, in turn, caused the rupture of the pipe. Subsequently, the aluminum pipe burned in the oxygen rich atmosphere, setting off further explosions and fires. It would seem, therefore, that two questions are posed; first, how much heat is needed to cause an explosive reaction between finely divided aluminum and pure oxygen, and second, after an explosion how strongly will various materials resist burning and other damage due to fire and thus confine the effects of an accident.

W. Mounce
International Nickel Co., Inc.

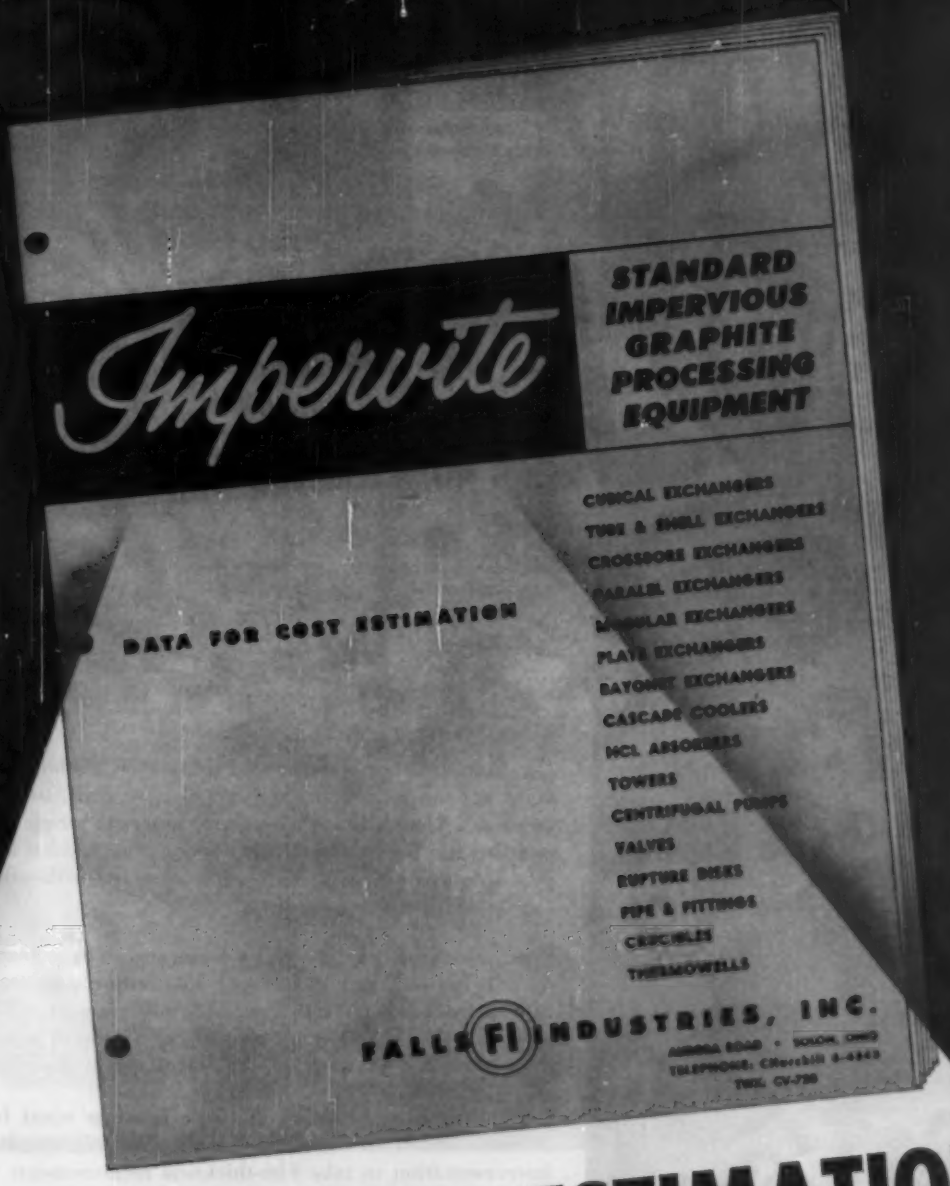
Correction noted

To the Editor:

The *Chemical Engineering Progress* issue of September 1960 contains an article on "Instrumentation and Control of Nuclear Power Plants," which I prepared earlier.

I am somewhat disturbed by the fact that some of the figure captions do not relate to the figure which they were supposed to identify. The caption under figure 9 should have been that appearing under figure 11; that under figure 10 should have been that appearing under figure 9; that under figure 11 should have been that appearing under figure 10.

C. F. Obermesser
Westinghouse Electric Corp.



DATA FOR COST ESTIMATION

Falls Industries provides this 32-page report to keep busy processing people up-to-date on the latest designs and costs of impervious graphite processing equipment. Sixteen different types of equipment are covered from Hydrochloric Acid Absorbers and Cross-Bore Heat Exchangers to Rupture Disks and Thermowells. Information supplied includes standard sizes, dimensions and costs.

Because Falls Industries is so active in developing new and improved impervious graphite processing equipment, this cost and standards report is periodically revised. This present report is the third revision since this service was inaugurated. It is available on request to Engineering Department . . .

For more information, turn to Data Service card, circle No. 75

FALLS FI INDUSTRIES, Inc.

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One of a series

Catching the Drift of Gyro Bearings

The fantastic accuracies needed by inertial guidance systems for space flight depend on the suppression of gyro drift, the tendency of a gyro to precess from minutely occurring internal torques. Particularly puzzling has been the problem of "jogs," or sudden axial shifts, within gyro spin-axis bearings. Shifts of but one ten-millionth of an inch can cause serious steering error.

Specialists at the GM Research Laboratories have found that the real key to drift lies in the thickness and distribution patterns of bearing lubricating films. Only a tenth of a milligram of oil — equivalent in volume to less than two-thousandths of a drop of water — is required in a gyro bearing, but even this amount unevenly distributed may cause jogs.

Conducting unique studies of single bearings apart from rotor assemblies, GM Researchers use a hydrostatic spindle and special instrumentation to take film-thickness measurements they compare with hydrodynamic theory. Jogs, due to excess oil supply, have been analyzed in relation to surface oil transfer and separator feed control, ball spin orientation, displacement, and differential heating and ball wander.

This experimental and analytical approach is achieving progress toward jog-free, stably distributed, and suitably thick oil films required in high-precision bearings. It is a further example of the critical and advanced research General Motors carries out in seeking "more and better things for more people."

General Motors Research Laboratories

Warren, Michigan

The fluoresced streaks show the disturbed "wake" of the lubricating film during bearing operation. The active part of the film, too thin to fluoresce visibly, averages ten-millionths of an inch in thickness.

For more information, circle No. 14

THE ORBIT OF APPROVAL...

From Brooklyn to Bangkok . . . Bakersfield to Baden-Baden . . . wherever materials are processed, MIKRO-Products are doing a job that rates a universal nod of approval. It is this endorsement by leading users of MIKRO grinding, air conveying and dust collection equipment that has moved MIKRO-Products into a leading position among suppliers of processing systems. But more important, to meet the requirements of customers everywhere, MIKRO Engineering is continually creating new equipment for new uses . . . MIKRO Laboratories are developing more effective methods for processing an endless variety of materials . . . and MIKRO Service is set up to provide on-the-spot solutions to processing problems throughout the world! Bulletin 571.

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MIKRO-PULVERIZER — High capacity . . . dry or liquid milling . . . precise particle size control.

MIKRO-AIRLOCK — For continuous dustless discharge or feeding.

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MANUFACTURING FACILITIES: United States, Canada, Continental Europe, British Isles.

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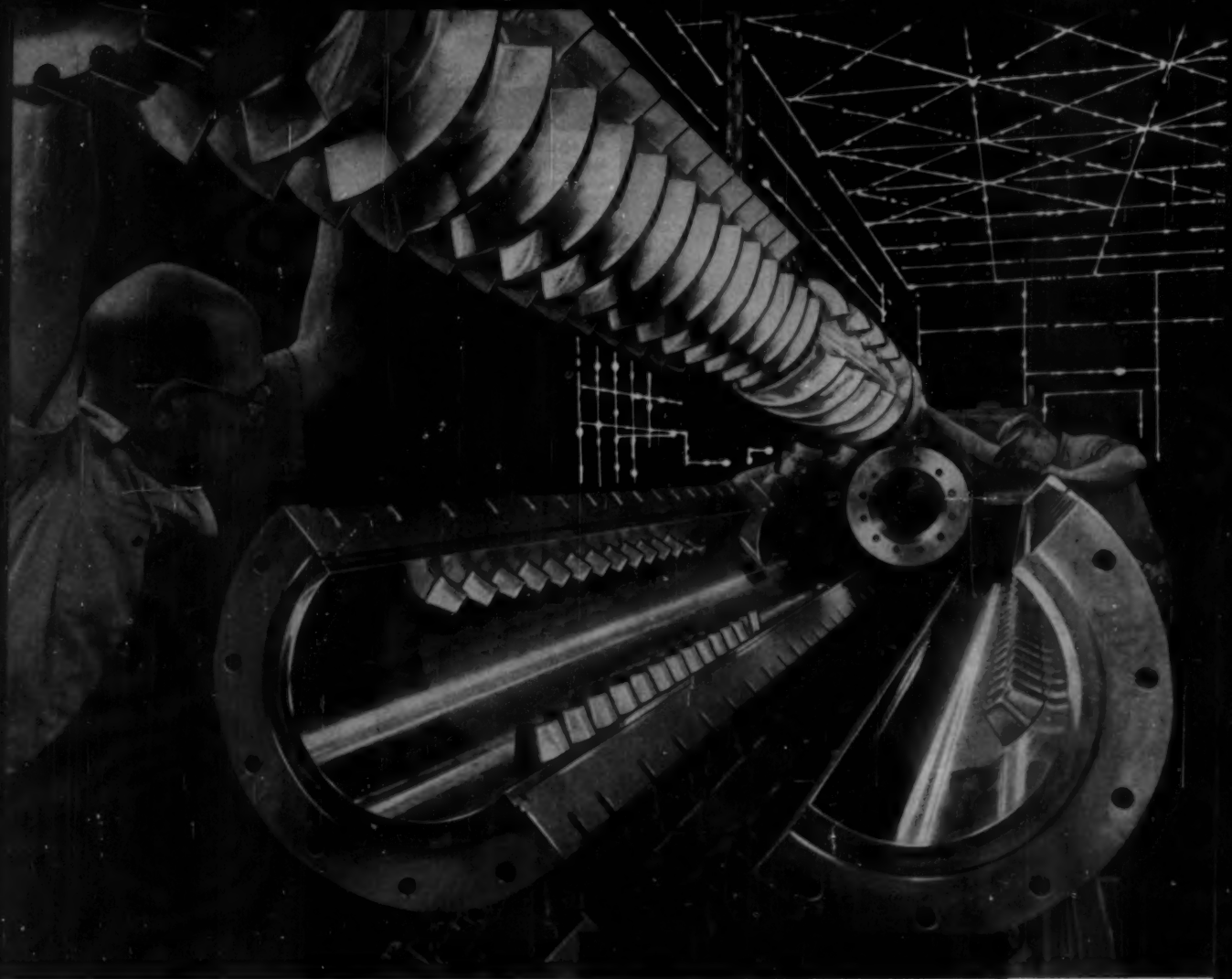
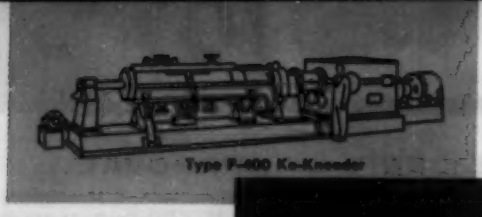
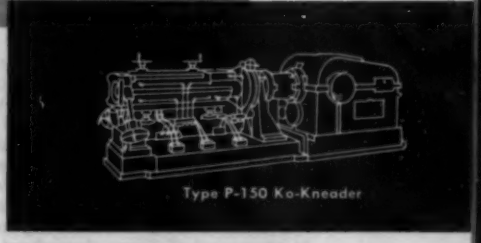


B·P

KO·KNEADERS (LIST SYSTEM)

precision built for efficient continuous mixing


Type P-400 Ko-Kneader


Type P-150 Ko-Kneader

Precision built and skillfully engineered Baker Perkins Ko-Kneaders will convert your inefficient batch process to faster, more continuous operations. Less floor space is required and maintenance costs are materially reduced. With a Ko-Kneader, you not only get more production at less cost, but you give your customer a superior product, too.

B-P Ko-Kneaders are now mixing a wide variety of products such as plastics, carbon electrodes, food specialties, floor tile, solid rocket propellant fuels and many others. From this experience, proper recommendations can be made for your operation. However, if a new mixing problem is involved, test demonstrations can be arranged in the Baker Perkins Laboratory. Write today for engineering manual K-57 or contact your nearest Baker Perkins sales engineer.

For more information, turn to Data Service card, circle No. 67

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BAKER PERKINS INC. CHEMICAL MACHINERY DIVISION
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Engineers role in managing tomorrow

IN RECENT YEARS THERE has been an increase in the number of companies adopting the "dual-ladder" concept of professional advancement. Under this plan engineers have not had to shift into administrative positions in order to advance economically. This permits the purely technical minded individual to continue exercising his professional skill, unfettered by administrative problems or the worry about falling behind his contemporaries who make the shift into the administrative area.

Despite such commendable plans, the trend is toward the engineeer becoming more deeply involved in the broad functions of engineering management. Howard Bunn, Vice Chairman of Union Carbide Corp., reports that over 46% of the company's engineers are involved in management. The Engineering Management Conference, sponsored jointly by A.I.Ch.E. and eight other societies, took a look at "Managing Tomorrow" at its Eighth Annual Meeting. The overwhelming concensus was that the engineer would be playing a much broader role in the future, like it or not. Considered opinions of the speakers emphasized this point.

Complexity requires organization

The nature of modern technology leans towards increased complexity, size, and scope of projects, said Herbert Shepard, Case Institute. If engineers are to work in organizations of ever-increasing complexity, then like organization managers they will require greater organizational skill as managers of their own interpersonal and intergroup relationships.

The competitive world situation means a substantial proportion of our technologists will have to cease being homebodies and become involved in the international scene, according to C. C. Furnas, chancellor of the University of Buffalo. The engineer, working in close liasion with the pure scientist, must necessarily play a most important, perhaps dominant, role in making the decisions and determining the management pattern of our future national program. The necessary background for such a responsibility will involve more than a compilation of facts, familiarity with handbooks, facility with the slide rule or expertness with computers, he said.

The "individual professional" (the technical specialist, the engineer, the chemist, the production scheduler, etc.) is responsible not only for focusing his own attention and work on the contribution to the common venture and effort, said Peter Drucker, New York University. Additionally, he is responsible for turning out his results, his knowledge, in such a form that it can be understood and used by people who do not share in his knowledge. He must learn to see his own work from a managerial, enterprise-focused, and contribution-directed point of view, Drucker said.

Whatever his work, the professional worker in any company adds economic value—as a *businessman*—said Harold Smiddy, General Electric V.P. Since he shares this purpose with both managerial and non-managerial associates, he can react with personal interest when he reads or hears the word "businessman" used. More often than not the reference will be to him. On still another front, virtually unlimited opportunities are available for direct or indirect participation in community work. The professional worker can—and should—use his unique combination of knowledge, skills, and interests in helping improve government, schools, roads, churches, hospitals—the list has no end, said Smiddy.

Engineering management and the unknown

It seems reasonable to predict that the pace and complexity of our technology will continue to increase. For the engineering manager this means accepting as a characteristic of his assignment the responsibility for handling the unknown, said Gerry Morse, V.P. of Minneapolis-Honeywell. For example, in the design of a space vehicle, when he is confronted with differences of opinion between his aerodynamicist, his metallurgist, and his biochemist, he often will be required to make his decision in the absence of the comfortable assurance that he is doing so from personal knowledge or experience. In a way, this is a brand new characteristic of the engineering management job. It represents, Morse stated, the introduction of intuitive judgment, sensitivity to subtleties of the personal assurance and professional certainty of the parties, and the ability to gamble successfully on what he judges to be facts as against what he judges to be assumptions or unproven conclusions.

opinion and comment

The Ch. E.'s changing world

AN EXPLODING TECHNOLOGY is drastically affecting the future of chemical engineering. Where is it taking us? F. J. Van Antwerpen, Executive Secretary of A.I.Ch.E. charted some of the highways and by-ways ahead in a speech presented before the Congreso Internacional de Quimica Industrial meeting in Barcelona, Spain. His comments, some of which are reflections of the work of the Committee on Dynamic Objectives, are outlined below.

The rapid growth of technology will cause a much greater rate of obsolescence in engineers in the future than it has in the past. and in the past it has been quite high. Our hope is to turn out a professionally oriented engineer who realizes that his education, professional and otherwise, has only begun when he leaves college. Industry is encouraging educational institutions in the deeper training of fundamentals, and is willing to share the burden of postgraduate training in specific industry and management methods for the new graduate.

The colleges must recognize that engineering is changing, and that science is giving us more to deal with than we are able to introduce into our educational system. We are not trying to make scientists in training chemical engineers. We are trying to give a man the necessary background of tools he must use, which we borrow or steal from science, so that he may successfully operate an important industry.

The Ch.E. of the future is going to have to know something about the application of systems engineering to chemical process design. Adequate progress in the area is difficult, and progress will not be made unless there is an overall plan in the United States for laboratories, private and public, to pool their resources in some sort of organized research in this new area.

Without chemistry, chemical engineering would have little use for existing as a separate discipline. The Ch.E. must therefore be sensitive to developments in all phases of chemistry. These include reaction mechanisms, physical methods of chemical analysis, high polymer chemistry and physics, reaction rate theories, transport phenomena, applied quantum chemistry, kinetic theory, molecular simulation methods, surface chemistry, etc.

In the near future he must embrace the chemistry of high temperatures for work in flames, plasmas, and shock waves. Just as he is investigating high temperatures and speedy reactions, so he is also worried about the behavior and properties of substances at extremely low temperatures.

What are the solutions?

Several broad solutions are available for present problems which will pave the road for the future, said Van Antwerpen.

1) While chemical engineering has turned out excellent and adequate engineers for the chemical process industries—and there are 24 of them—it has not been able to keep them solely as Ch.E.'s. Their society must find a way to remind them that their education makes them fundamentally chemical engineers.

2) In the past chemical engineering has been characterized by an increasing amount of attention to decreasing areas of interest. Ch.E.'s must deliberately train their sights on the frontiers of science.

3) Chemical engineering has its head in science and its feet firmly in economics. Our problem is to educate enough Ch.E.'s broadly enough so they comprehend the possibilities in the continuing scientific discoveries.

L.R.

ERWIN VON ALLMEN
Arthur D. Little, Inc.

CEP feature

Economics are basic for plant location

Market orientation is current trend in locating chemical processing plants.

A PROPERLY SELECTED plant site optimizes all the cost and revenue factors that will bear on its operations. Except for a few noneconomic considerations such as national defense plant dispersion policies, plant locations are determined by a dollar and cents appraisal of market and raw material locations, labor costs, transportation and storage facilities, taxes, waste disposal, safety, and the like. The ultimate goal is maximum profit.

In the chemical and allied industries, as in some others, site selection has historically focused most importantly on the location of raw materials and consuming markets. Disadvantages among other factors are generally accepted to accommodate the materials shipping problem. The availability and cost of labor, which are so significant in most manufacturing operations, are usually only a small element in chemicals production.

In brief, a decision on where to locate with regard to raw material supply or market demand for a given product would involve a very simple analysis. It is common knowledge that shipping cost per unit distance decreases with increasing distance, therefore, there would be no question of intermediate locations. A plant would locate either at the source of its raw material or its customers, depending on which is basically least costly to ship—raw materials or finished goods.

This simple approach is usually a good one, but in any given case the basic physical and economic characteristics of the raw materials and finished goods should be considered. These may quickly limit the site alternatives, suggest refinements in plant location analysis, and point up trends in transportation techniques and economics which are pertinent to the problem.

Physical state dictates site

The chemical community contains numerous examples of plant site selection being dictated by the physical state of the raw materials or finished goods. Shipment of gases is a particular problem because of their low densities and costs attendant on shipping large quantities except by continuous flow in pipelines. Liquefaction for shipment introduces costs of refrigeration and/or pressurized shipping vessels, and special handling and storage facilities.

An example of a gas raw material situation and the techniques being developed to adapt to it is the petrochemical giant, ethylene. Ethylene chemical plants (polyethylene, ethylene oxide, vinyl chloride, etc.) have traditionally been "across-the-fence" customers of ethylene producing facilities. However, in recent times, new transportation technology has broadened ethylene plant location flexibility. For example, liquefied ethylene is now being shipped by stainless steel tank truck from Sarnia, Ontario, by Imperial Oil Co., Ltd. to Allied Chemical at Tonawanda, N. Y.

The most spectacular development is the Gulf Coast ethylene pipeline system. It has permitted the ethylene chemicals industry the benefits of high volume operations among the suppliers who can furnish ethylene to more than one plant, more reliable supply, and greater breadth of selection for their plant sites. This complex involves about 400 miles of pipeline exclusively for ethylene supply to a dozen ethylene customers from a half dozen ethylene suppliers. The Gulf Coast area also has acetylene and hydrogen piped between suppliers and customers as a matter of course. These are indications that the shipping limitations of gaseous raw materials are being whittled away. The Methane Pioneer experiment for transoceanic shipment of natural gas points toward even broader horizons in delivering low cost gases over long distances. However, in comparison with shipping liquids and solids, except for pipelines, gas transportation is still limited to short distances for large volume items within the framework of the U.S. chemical industry.

Physical state is likewise of concern in locating plants for awkward-to-ship finished goods. Generators for conversion of calcium carbide to acetylene

frequently are located where the acetylene is needed rather than where the carbide is available, all other things being equal. Even though more than half the weight of calcium carbide is valueless in terms of its acetylene equivalent, it is generally more economical to ship this solid material than acetylene gas.

Not only gases are involved in consideration of physical state. A material such as a foamed plastic fabrication is more likely to be produced near its markets rather than its resin source to reduce shipping volume requirements.

Composition affects plant site

The chemical composition of a product or raw material often dictates the producing site to reduce shipping unwanted weight. An example is the thermal conversion of limestone to lime. This process is ideally carried out near the limestone mining site rather than the lime consuming point. This avoids shipping the unwanted carbon dioxide which constitutes nearly half of anhydrous calcium carbonate. A corollary problem which enters here, however, is shipment of fuel to the kiln. Actual site selection involves striking a working balance.

This same theory works in reverse to foster the installation of plants for sulfuric acid from sulfur near the acid consuming point rather than sulfur source. The conversion to acid chemically involves only the addition of oxygen (air) and water to sulfur. The required air and adequate water are almost universally available so that sulfur can be shipped alone as a sort of "instant H_2SO_4."

A more general problem closely allied to that of chemical composition involves the occurrence of useless foreign material in raw materials and the question of shipping concentrated finished goods. Many chemical processes for recovery of valuable materials from their ores must handle raw materials which are so dilute in terms of the end product that extensive shipping is prohibitive. The result is a tendency to locate recovery plants at the ore sites, which is what the domestic integrated lithium ore operators have done. The alternative is beneficiation steps to effect preliminary separation of waste material at the ore site, an arrangement long studied for utilization of low grade iron ores.

The counterparts in the end product categories are products which are necessarily sold with a high content of low valued diluent, hence are produced near their markets. The classic examples would be water solutions, for instance, sodium hypochlorite bleach which is no more than an aqueous caustic solution of chlorine. Bleach plants, which add chlorine and caustic soda to local water and bottle the product, are highly localized in the areas of high population density.

Other factors to consider

There are an assortment of other factors related to raw materials and end products that affect plant site selection.

Hazards can be important; for instance, dynamite is made by mixing nitrated polyols with inert material near the "explosive oils" nitration production site, and as such is raw material-oriented. Nobel's invention of dynamite was spurred by the hazard involved in shipping and handling shock-sensitive nitroglycerin. Conversely, ammonium nitrate is shipped dry to the working location in explosives applications. It is converted to a finished explosive by mixing with petroleum fractions on the spot to make "sensitized ammonium nitrate" which cannot be safely shipped to market. A related hazard problem is the location of some operations handling radioactive materials in areas where accidents might not endanger large segments of the population, or where shipment of waste materials in large quantities is minimized.

There are some elements of manufacture not usually thought of as raw materials which sometimes enter into site location decisions in much the same way. Availability of low cost electric power is critical in electrochemical operations. Examples are production of calcium carbide, chlorine and caustic, sodium chlorate, and furnace phosphorous; all of which have power as a major manufacturing cost component. Using as a "rule of thumb" 1 mill per hundred miles per kilowatt hour power transmission costs, a good low cost power source making 3 mill power loses much of its appeal a few hundred miles away. The presence of good plentiful process water for soap or paper making and sunlight for solar salt are other examples of chemical and allied industry operations dependent on "fringe raw materials."

Lastly, there is the broadly accepted policy of shippers charging more to move finished goods than their lower valued raw materials. This has long been the incentive to locate near the markets, but recent trends, discussed below, are beginning to minimize the differentials.

Shipping methods and trends

Since chemicals are shipped in every conceivable form and carrier, comparison of relative carrier costs is of interest. The following 1958 average revenue per ton mile figures have been developed in an exhaustive study of basic carriers: rail, 1.5¢; trucks, 6.2¢; and domestic trunk airlines, 23.8¢. Popular estimates for other carriers show 0.5¢ for barge and 0.2¢ for pipeline transportation (*1*). All these values, of course, are for broad comparisons only; specific shipping routes and methods for specific products might alter these relative standings considerably. In general, the lower cost methods sacrifice speed, flexibility in products which can be handled, and breadth of points which can be reached.

The relative importance of the shipping media might be deduced from their tonnage shares in intercity traffic, recently estimated (for all cargoes) as follows: rail, just over 40%; motor carriers, about 20%; pipelines, over 15%; and inland waterways close

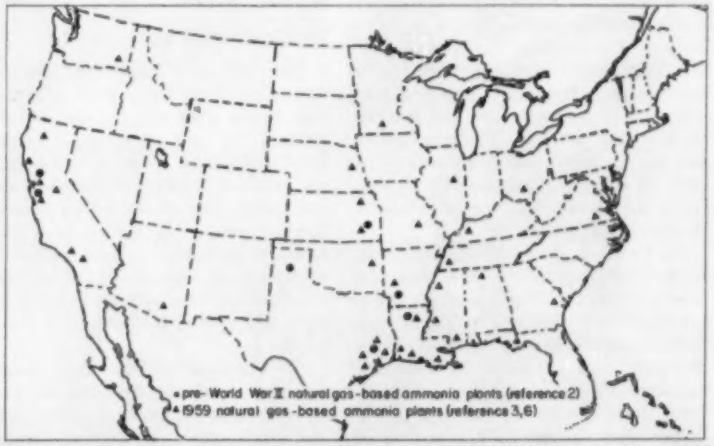

Figure 1. Natural gas-based ammonia plants before W.W. II and in 1959.

to 10%; with the balance in coastal shipping and air freight (*1*). In absolute volume the railroads have barely held their own since World War II. Inland waterways, motor carriers, and pipelines have been the big growth areas.

Trends in the transportation field in recent years have been almost universally favorable to the chemical industry. Adverse rate increases have occasionally arisen and some initially promising items such as the Saint Lawrence Seaway have not developed as rapidly as originally expected. In general, however, there has been a strong undercurrent of transportation technological revolution and new rate formulas which are permitting new degrees of flexibility in plant site selection.

Transportation revolution

The recent rash of specialized vehicles alone is indicative. Included are the road and shiplane gas carriers. Other examples are trucks for a regular 100 mi. haul of molten aluminum; 30,000 gal. tank cars, three times the usual volume; 3000 gal. rubber bags for chemical liquid hauling in ordinary vans; pneumatic conveyors for rapid handling of granular materials; various specialized tank trucks from steel and aluminum alloys and/or lined with glass, resins, and the like; ships for U.S.-to-Britain delivery of molten lard at 105°F; hopper and tank trucks for solids shipping; and the recently announced GAF ethylene oxide tank truck operating up to 300 mi. out of Linden, N.J. Pipelines are showing new versatility with underwater movement of molten 300°F sulfur by Freeport Sulphur or slurried coal over 100 mi. (from Georgetown, Ohio, to Cleveland Illuminating Co.'s Eastlake plant near Cleveland).

Perhaps the most heavily publicized innovation in intercity transportation is the "piggyback" technique combining truck and rail. This is of particular interest for shippers of higher valued chemicals. The five basic plans being reviewed are as follows:

Plan I. A trucking company, generally a common carrier, places his trailer on a railroad-owned flatcar.

Plan II. A railroad owns and operates the highway unit or trailer and the flatcar. This releases a railroad from its dependence on terminals and permits door-to-door service to shippers without sidings or without using sidings of rival railroads.

Plan III. The shipper owns the truck-trailer and arranges movement of his trailer aboard a railroad-owned flatcar.

Plan IV. The shipper or manufacturer owns, controls, or leases both trailer and railroad car.

Plan V. Joint rates and routes are published by the railroad and trucking companies from origin to destination.

Plans III and IV have already been accepted by the ICC. The only restrictions on the nature of the cargo in these plans are that it should not be dangerous or call for special handling, and it must not overload the trailers. Missing is the traditional rate discrimination against higher valued materials. This means that the higher valued chemicals shipper can begin to look at plant sites much farther from his markets and vice versa.

Similar techniques have also been developed for trailers on ships, which will make water based plant sites more popular.

Actually, both of these techniques are specialized examples of the broader container problem. In classical container concepts, a cargo is packed at its production point in a standard size box which can be moved from one transportation medium to another with minimum handling right to its point of use or storage. Current standard containers range up to 900 cu. ft. and present new possibilities to bulk chemical shippers or buyers. They permit transfer between truck, rail, and water carriers without actually rehandling the cargo in transit.

The growing flexibility of transportation facilities is certain to make chemicals shipping simpler. It is too early, however, to state whether market or raw material plant sites will be favored in the future. The only safe conclusion might be that tighter analysis of available and potential shipping methods will be dictated in future plant location decisions.

Trends in plant location

Although there are notable exceptions, the U.S. chemical industry in recent years seems to be moving away from its raw materials toward its markets. Perhaps the most impressive example is the petrochemical segment which makes up over 55% of total chemical industry dollar sales. This industry originally developed in areas of the U.S. where raw materials were cheapest. In fact, much of the impetus behind petrochemical development was in the utilization of materials such as refinery off-gases and LPG which were used as fuels or disposed of by flaring. In recent years, the development of processes to recover usable petrochemical raw materials from refineries, the extension of the natural gas pipelines, and the actual shipment of petroleum fractions to distant points for petrochemical upgrading have expanded the plant sites for petrochemicals all over the country.

The history of site selections for production of synthetic fertilizers and their components shows an interesting mix of market- and raw material-oriented elements. The three principal plant foods are nitrogen, phosphorus, and potassium. These are largely supplied as ammonia or its closely related derivatives; various superphosphates, phosphoric acid, or diammonium phosphate; and potash. Potash is usually included without involving chemical processing and is frequently omitted, depending on soil conditions, and does not merit further study.

Synthetic ammonia is produced by direct combination of hydrogen and atmospheric nitrogen, so that the governing raw material source is the hydrogen supply. Hydrogen for this purpose has over the years been obtained from natural gas reforming, refinery by-product, electrolytic cell by-product, and processing of heavier refinery cuts. The trend in natural gas-based ammonia plant site selections is one of change from almost exclusive raw material orientation to a high degree of market orientation.

Figure 1 shows the U.S. natural gas-based ammonia plant locations prior to World War II. It can be noted that they are loosely grouped in the natural gas producing areas of the Southwest and West Coast.

Table 1. U.S. ammonia production (3,4).

Source	Ammonia capacity (1000 tons/year) Pre-W W II	1959
Natural gas	506	4099
Others	1195	737
Total	1701	4836

Over the years, a number of new factors entered into decisions on location for plants of this type which significantly affected site selection. First, ammonia, either alone or combined, became a much more widely accepted source of nitrogen for plant food applications. Second, the expansion of natural gas pipelines made this raw material available in the plant food market areas. Third, technological developments made the use of natural gas a preferred hydrogen source in ammonia synthesis as shown in Table I.

These influences combined to produce the current plant site situation shown in Figure 1. It can be seen that the number of natural gas-ammonia plants in the basic gas producing

areas has increased considerably. More pertinent, however, is the fact that a number of producers have found it more advantageous in their particular circumstances to locate in the heavy agricultural producing areas of the Midwest. The case is not clear cut, but the trend is obvious.

A more complex situation exists in the phosphorous segment of the plant food industry, where there is considerable evidence that a trend toward raw material orientation is operating. The natural raw material for agricultural phosphates has been the phosphate rock deposits of Florida and the Rocky Mountains. Over the years a major phosphorus source for mixed fertilizers has been normal superphosphate which has tended to be produced in small market-oriented plants. Figure 2 shows the location and number of these plants in the U.S. by state, although this illustration is slightly deceptive in indicating geographic distribution. The farm states west of the Mississippi have needed less superphosphate because their low soil potash requirement precludes the necessity of mixed fertilizers. Phosphorus is frequently added in other forms, alone or combined, such as diammonium phosphate. Also, the superphosphate plants there tend to be in smaller numbers of large units.

Recently, the popularity of triple superphosphate, a more concentrated phosphorous source made from the same raw materials, has been increasing markedly, as shown by Table 2.

Table 2. U. S. superphosphates (4).

	Production (1000 tons P_2O_5)		
Year	Normal	Triple	Total
1940	877 (83%)	180 (17%)	1057
1959	1395 (61%)	893 (39%)	2288

The production of triple superphosphate is a large scale process which, due to technological characteristics, has tended to operate most economically near the phosphate rock source. Figure 3 shows the plant locations for both 1934 and 1960 to illustrate this trend. Note the very high plant concentration in the Tampa, Florida area.

The combined effect of these factors is to shift the over-all superphosphate plant food supply from the numerous small market-oriented normal superphosphate plants to the large raw material-oriented triple superphosphate plants.

On a broader scale, the trend towards the nonmarket-oriented producing facilities has moved ahead rapidly with the advent of by-product recovery processes. In these cases, material of economic value is produced irrespective of its markets. Some examples of this are the oat hull utilization development by Quaker Chemical, which contributed so heavily to industrial furan chemistry (e.g., nylon from furfural); the original petrochemical waste utilization processes; the recovery of chemical values such as lignin sulfate from paper processing; and, of course, the production of a broad line of chemicals by the coke oven operations of the steel industry.

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Other chemical operations have shown an erratic pattern of site selection in their history. For many years bromine was derived from the brine wells of Ohio, West Virginia, and Michigan for use in these industrial areas in preparation of medicines, photographic chemicals, and war gases; thus indicating both raw material and market orientation. In 1924, the SS Ethyl (a ship specifically outfitted for the purpose) demonstrated the feasibility of recovering bromine economically from the sea. Subsequently, a sea water recovery plant was built at Kure Beach, North Carolina, in 1934, and the bulk of U.S. production was coming from this raw material-oriented plant by 1937.

At present, over 80% of U.S. bromine capacity is still sea water-based, most of it at the Ethyl-Dow Chemical Company plant at Freeport, Texas. However, Freeport might more rightly be considered a market-oriented plant site to provide bromine for synthesis and formulation of petrochemical-based bromide components in antiknock mixtures produced in the Gulf Coast area (5).

In summary, the general U.S. trend seems to be toward market orientation of chemical processing, but there are enough significant deviations to preclude rigorous categorizing.

Analytical methods

The assumption was made that in determining a plant site, the item with minimum shipping rate, either raw material or finished product, need only be determined. The nonlinear nature of shipping cost with distance would minimize total shipping cost by maximizing distance of the least expensive-to-ship material. This, in most cases, is an unworkable oversimplification. Actual situations involve more than one raw material, product, or market. The astronomical number of possible combinations in some cases has prompted a number of highly sophisticated analytical approaches to the problem that are beyond the scope of this article. Operations research on the problem is at least 20 years old.

Quite frequently, a simpler quick analysis is sufficient. To demonstrate, Table 3 shows the situation for a hypothetical diammonium phosphate plant site selection. The elements are a Louisiana sulfur source, Florida

Figure 2. Normal superphosphate plants located in each state in 1960.

phosphate rock, complete flexibility in selection of ammonia plant site, and the market to be served approximated in size and location by the Midwestern cities indicated in Table 3. Actual shipping rates are employed. The logical site arrangements would be either:

Case I. Ship sulfur (for sulfuric acid) to the Florida phosphate fields, produce phosphoric acid, ammonia, and finished diammonium phosphate in Florida, and ship the finished product to the Midwest market area shown.

Case II. Ship phosphate rock and sulfur to a market-oriented Midwest point (arbitrarily Joliet, Illinois), produce ammonia and finished product there for subsequent shipment to the markets.

Cast III. Produce the phosphoric acid in Florida and ship it to the Midwest for conversion with local ammonia to finished product, then ship to market.

This simplified analysis heavily favors Case I, with a total shipping cost of $14.68 per ton of finished product vs. $23.14 and $19.48 for Cases II and III respectively. It is intuitively unlikely that any refinements in shipping cost calculations which might be introduced could change this conclusion. The other site selection economics can then be spot checked for items such as labor or taxes, which might be able to offset this Case I shipping advantage. If no really large disparities in other factors are apparent, this analysis can be used as at least a good first approximation in site selection.

Table 3. Freight cost analysis for diammonium phosphate operation.

Annual sales: 100,000 tons of diammonium phosphate

APPROXIMATE RAW MATERIAL REQUIREMENT:					
1. Phosphate rock (34.3% P_2O_5)			135,000 tons		
2. Sulfur			40,000 tons		
3. Ammonia			22,000 tons		
CASE I: COMPLETE FACILITY IN FLORIDA					
A. Raw material transportation costs					
	Tons	Freight rate, $	Total Cost, $		
Phosphate rock ..	135,000	0	0		
Sulfur	40,000	4.06	162,400		
Ammonia	22,000	0	0		
					$ 162,400
B. Finished product transportation costs, from Florida to:					
Decatur, Ill.	20,000	12.00	240,000		
Madison, Wis. ..	10,000	13.60	136,000		
St. Paul, Minn. ..	10,000	15.00	150,000		
Des Moines, Ia. ..	20,000	13.80	276,000		
Kansas City, Mo.	20,000	13.40	268,000		
Indianapolis, Ind.	20,000	11.80	236,000		$1,306,000
	(avg.: $14.68/ton product)		Total....		$1,468,400
CASE II. COMPLETE FACILITY IN MIDWEST					
A. Raw material transportation costs					
Phosphate rock...	135,000	9.82	1,325,700		
Sulfur	40,000	5.55	222,000		
Ammonia	22,000	0	0		$1,547,700
B. Finished product transportation costs, from Joliet to:					
Decatur, Ill.	20,000	5.00	100,000		
Madison, Wis. ..	10,000	5.00	50,000		
St. Paul, Minn...	10,000	10.60	106,000		
Des Moines, Ia. ..	20,000	8.00	160,000		
Kansas City, Mo...	20,000	11.00	220,000		
Indianapolis, Ind.	20,000	6.50	130,000		766,000
	(avg.: $23.14/ton product)		Total....		$2,313,700
CASE III: PRODUCE PHOSPHORIC ACID IN FLORIDA AND CONVERT TO DAP IN MIDWEST					
A. Raw material transportation costs					
Phosphoric acid ($54.4\% P_2O_5$) ..	85,000	12.00 (est.)	1,020,000		
Phosphate rock ...	0				
Sulfur	40,000	4.06	162,400		
Ammonia	0				1,182,400
B. Finished product transportation costs (same as in Case II)					766,000
	(avg.: $19.48/ton product)		Total....		$1,948,400

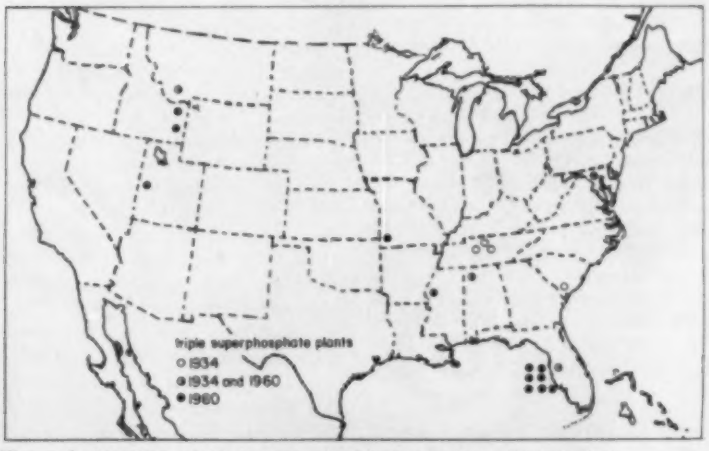

Figure 3. Location of triple superphosphate plants in United States.

Conclusion

In selection of chemical plant sites, raw material and market locations are traditionally the primary considerations. In a given situation any of a number of physical and chemical characteristics of the starting material or finished product may fix the site location fairly rigidly. New developments in shipping are minimizing restricting influences and increasing the flexibility available in plant site choice.

There has been a trend led by petrochemicals toward market orientation of the U.S. chemical industry. There is no indication whether new transportation technology will favor raw material or market orientation. Analytical techniques for determining optimum location are becoming increasingly sophisticated, but there are still some highly satisfactory "horse sense" approaches to this problem.

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New plant in town brings new people. The Field Project Manager leads the parade of new company personnel.

A. Dick Day
Du Pont Co., Wilmington, Del.

A new plant comes to town

Every company has public relations whether it likes it or not. The only question is whether its public relations are good or bad.

There is a great premium in getting off on the right foot community relations-wise when a plant first comes to town. Mistakes, omissions, and errors of judgment at the beginning can plague a plant for years to come.

Since the close of World War II, the Du Pont Company has built 34 new plants in as many different sites in 14 states, with a total investment of almost $2 billion. From this experience has evolved a fairly standard operating procedure for introducing a new plant to a community. The procedure is not rigid and the mechanics vary according to the requirements of the situation. But the principal objectives are always the same: to fill, as speedily as possible, the huge information void which exists after the initial announcement; and to define in concrete terms the company's role as a community neighbor. These two objectives deserve more detailed mention.

At the outset it must be recognized that news of industry coming to town generates a tremendous amount of interest and excitement. With communities intensively competing to attract industry, with local businessmen being asked to dig deep into their pockets to provide funds for industry-attracting promotional schemes, with industrial development commissions sending out colorful brochures by the bushel, the announcement that a "big one" has been landed is news with a capital *N*. Consequently, the thirst for information about a company and its plans is at its peak during the early stages following the initial announcement. Companies would be well advised to come prepared to slake this thirst for, in the absence of facts, rumors grow and multiply. When people have nothing better to go on than speculation and conjecture, a $1-million project is distorted into the $100-million class, bringing the inevitable letdown and disappointment when the true facts are made known.

The second objective can, perhaps, best be described in the words of a veteran Du Pont Plant Manager, "I am convinced that the master key to sound community relations lies in having it clearly understood what the community can expect of a plant and what it cannot expect." Having the rules of the game and the responsibilities clearly defined goes a long way toward preventing possible misunderstanding and bitterness. There is no better time to start this educational process than right at the beginning.

Foster local press cooperation

Community relations, or, in the broader sense, public relations, start even before the final decision has been made on the selection of a particular plant site. Today, it is not unusual for a company to option a number of potential plant sites for a particular project before deciding on "the" site. No matter how quietly optioning is conducted, word leaks out and sooner or later reaches the ears of the press. The next step is for a local editor to call Wilmington and ask for confirmation. If his facts are substantially correct and we are optioning in his locality, then the conversation goes as follows:

"Yes, we are optioning land in the vicinity of town *X*, but we are also optioning land at a number of other locations. Until the final decision is made, we would appreciate your holding this information in confidence. Obviously, a news break at this time might well drive land prices out of reach and make the site uneconomical. Also, if the final decision is to select another location, a news story at this time would only build up the community for a letdown which would do neither your paper nor the Du Pont Company any good. However, if you will cooperate with us, we in turn will be most happy to cooperate with you. In the event Du Pont locates in

your community, we will time our release to fit your schedule."

Literally dozens of such calls have been handled this way and in no single instance has this confidence been violated.

Once the site has been selected and the project authorized, public announcement is made as speedily as possible. The presence of strangers in a small town, surveyors laying out the plant site, engineers making test borings—all point to some unusual activity and give way to rumors. At the earliest possible opportunity, we put out a public release, giving as complete information as possible. Included in this release are such details as the location of the plant, some indication of the magnitude of the project, the product to be manufactured, the number of people to be employed at peak of construction, the number of operating personnel, and any other background information available at the time.

Since most communities have competing morning and afternoon papers, one of the first problems is to decide which paper is to be given the initial release. If one of the papers had advance knowledge and cooperated by withholding it, the decision is obvious. If this is not the case, then an arbitrary selection has to be made. Frequently, the solution is to furnish the follow-up paper with more detail and to assure the editor that it is our policy to try to rotate news breaks and that he will have first crack at the next major announcement coming from the plant. Simultaneous releases are, of course, given to the radio, TV, and wire services.

As previously stated, it is almost impossible to overestimate the enthusiasm generated in a community by the news of an industrial plant coming to town. No matter how much information is contained in the original release, it is never enough. Background material on the company and its products, pictures of similar plant installations at other locations, together with pictures of top personnel, are usually requested by the local press and utilized to good advantage.

The original announcement and background data do little more than whet interest and appetite for more information. The school superintendent wants to know whether present facilities will be adequate; real estate operators want some estimate of the market for home buying or for rentals; highway officials are concerned over the adequacy of roads; local banks want to know whom to contact to vie for the plant banking account; health and pollution officials, together with sportsmen's groups, are concerned over the adequacy of pollution abatement facilities; local suppliers and contractors want to know how to peddle their wares and services; and a number of citizens have a very fundamental question: "How do I go about applying for a job?"

Meet community leaders at lunch

One device for filling this information void which has proven effective at a number of new plant locations is the "get-acquainted" luncheon. As soon as possible after the initial announcement, Du Pont officials play host at an informal luncheon to a cross section of the community's influential citizens. The guest list, ranging from 60 to 80 people, includes the town fathers, prominent business and professional men, school officials, clergymen, members of the press and radio, heads of civic clubs, officials of the local Chamber of Commerce and industrial development group—in short, anyone who can be considered an opinion-molder in the community.

Following the luncheon, Du Pont officials take the floor in a series of five- to ten-minute talks. The General Manager of the department responsible for the plant, for example, might state his views on issues of the day and cite the reasons leading to the selection of the site; the Director of Manufacture gives a non-technical description of the plant and its processes and talks to local interests in terms of number of jobs, type of personnel required, pollution abatement facilities, and the like; and the Construction Field Project Manager, the man in charge of building the plant, covers such points as the company's policy of purchasing locally where feasible, housing and school

Many talents are needed to locate, build, and operate the new plant. Some idea of teamwork required is shown here.

requirements of construction personnel, and the construction timetable.

While the main purpose of the luncheon is to satisfy the dual objectives of supplying information and defining the company's position in the community, there are several important corollary benefits. For one thing, it creates an interim series of contact points pending the arrival of the Du Pont construction contingent on the scene. People who are disturbed by rumors or in need of information know whom they can phone or write for an authoritative answer. They have the man's name. They have shaken hands with him. They know him.

The luncheon is also an act of neighborliness. The fact that busy officials in high positions took the time and trouble to visit them and break bread with them is a gesture that does not go unnoticed or unappreciated.

Finally, the luncheon serves to break down the concept of the cold, soulless corporation and pictures the company as it really is—an organization of human beings. To illustrate: At a West Coast plant site luncheon the General Manager turned to the Mayor and jokingly said, "Things will be different when we get out here, Mr. Mayor. For one thing, since we are in the dye business, I expect to see that white shirt you are wearing replaced by a colored shirt." Not to be outdone, the Mayor allowed that he would gladly wear colored shirts, provided that they were gifts from the General Manager. When the Mayor paraded around town the following week sporting a succession of shirts of gaudy hues, a very human image of the Du Pont Company was created—an image that hundreds of press releases with a Wilmington dateline could never achieve.

The "get-acquainted" luncheon is not the only device that can be used. A number of Du Pont departments prefer to skip the luncheon and achieve the same result by holding a ground-breaking ceremony. Others avoid group meetings, preferring to have their representatives circulate among key citizens on a person-to-person basis. No matter what the means, the ends are still the same—to provide information and spell out the company's operating philosophy during the period when interest runs high.

The field project manager's job

But despite all the releases and meetings during the early stages, the real burden of the community relations job falls upon the shoulders of the Field Project Manager and his staff. Until the Plant Manager arrives in the community a year or year-and-a-half later, the Field Project Manager is "Mr. Du Pont" in the eyes of the townspeople. His responsibility is not a light one. Not only must he direct the construction of a multi-million dollar plant to a successful conclusion, he must also provide the community relations leadership. The degree of success he achieves in this latter role determines, to a considerable extent, the community relations climate in which the plant will operate for years to come.

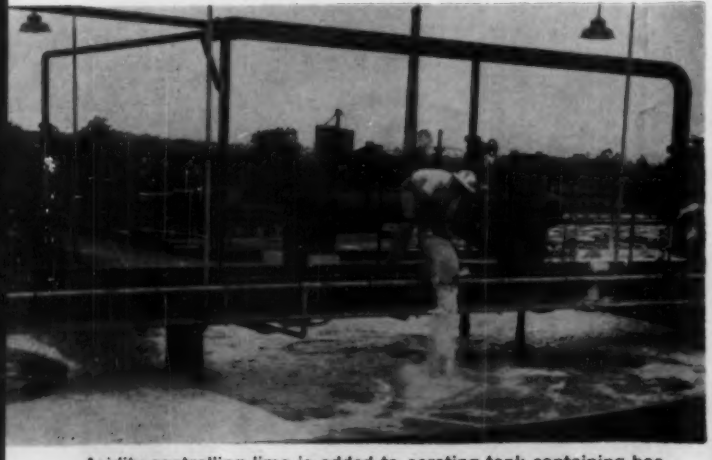
Admittedly, Du Pont enjoys one marked advantage in getting off to a good start. Since its central Engineering Department designs and constructs virtually all plants for the company's 12 operating departments, Du Pont personnel are present on a project from the very beginning. There is no break in continuity as in the case of an outside contractor.

Even with companies employing a contractor, however, continuity can be maintained in good measure by assigning a first-rate man to the site to represent the company during the construction phase. Du Pont's Field Project Manager, a member of the Engineering Department's Construction Division, has experienced new plant birth pains at a number of other locations throughout the country. He knows the company's operating philosophy in a community and is prepared to explain it.

Moreover, he knows that he is *expected* to explain it. Every Field Project Manager has been instructed by Construction Division management that it is fully as much a part of his job to establish sound community relations and to see that his people behave like responsible citizens as it is to build the plant successfully and on schedule. To this end, he is backed by top-flight supervision, many of equally long service and time-proven Du Pont ambassadors at many other construction sites.

He knows that he cannot duck or delegate his front-man role. When he is invited to speak before the Rotary, or Lions, or appear for a TV interview, he knows that it is he, as Number 1 Du Pont spokesman, who is wanted, and not an underling. In this connection, it is not unusual for a Field Project Manager to make as many as eight to ten public appearances a month during a project's early stages.

A company's community responsibilities . . . .



Acidity-controlling lime is added to aerating tank containing bacteria used to repurify plant waste as a part of pollution control program.

Fishing for pollution. Major part of community relations is keeping streams clean.

He must be alert and intuitive enough to sense local fears and dissatisfactions and be quick to stem them before they grow and fester. If local businessmen and manufacturers are fearful of Du Pont's disrupting the prevailing wage scale, for example, he must explain our policy and allay their fears. He must be prepared to outline the plant's practices on labor relations, integration, or any of the issues of the moment in that particular locality or section of the country.

To be attuned to community thinking he must develop a sounding board of townspeople in various walks of life—people on whom he can rely to keep him informed of the eddies and currents of opinion affecting the plant's relations. Needless to say, this is not a one-shot job, but a continuing one of nurturing and cultivating contacts so that mutual confidence is maintained.

He must stand ready and willing to play host to dignitaries and visiting firemen. He must be available to local school, highway, and town officials and assist them in forecasting needs in their respective spheres of interest. He must exercise good judgment in deciding the degree to which he will allow himself to be associated with individuals wishing to make political capital by claiming credit for bringing industry to town.

Above all, since the press provides the Field Project Manager with the fastest and most direct pipeline to all members of the community, he must cultivate and maintain good press relations. This he can do only by following a policy of complete impartiality between competing segments of the press and by recognizing that the plant is news and that it is the responsibility of the press to report news.

Indeed, he must carry this thinking one step further and realize that it is *his* responsibility to provide the press with news. One Field Project Manager even went so far as to institute a weekly news service, detailing a progress report of the week's work, together with appropriate photographs.

As time goes on and as key members of his staff acquire a stature of their own in the community, the Field Project Manager can gradually begin to delegate some of his front-man functions. His Service Superintendent, for example, can serve as liaison between the plant and press on routine matters, and the more articulate members of his staff can take on some of the less important speaking assignments.

But until the advent of the Plant Manager on the scene, the Field Project Manager is the man who before the eyes of all hoists the flag in the morning and hauls it down again at sunset. Once the Plant Manager takes up permanent residence in the area, however, the role of the Field Project Manager undergoes an abrupt change. It is then his job to make his exit as quickly as possible into the wings, leaving the stage to the man who will direct the destiny of the plant for years to come. This he does only after solidly entrenching the Plant Manager and his new staff in the community, using such media as press releases, personal introductions to key community figures, and introductory appearances before civic clubs.

A. D. Day is a field project manager for construction at Du Pont. Currently, he heads construction of the Film Department's new Mylar polyester film plant in Florence, S.C. Since 1955, Day had been field project manager for construction forces at the government's atomic energy materials plant. The plant was designed, built and operated by Du Pont for AEC. With the company since 1939, Day has held posts at the Hanford, Washington, atomic energy plant, and at several other locations. He is a member of ASME.

Community responsibilities

No discussion of community relations would be complete without mention of pollution. Due to the very nature of the chemical industry, the subject is bound to be a matter of community interest sooner or later—usually sooner. Therefore, it makes good sense to tackle it head-on at the outset.

In early speeches, at the get-acquainted luncheon, and even on occasion in press releases, we tell people that the problem of air and water pollution has long been of deep concern to the company. We cite a resolution of Du Pont's Executive Committee dating back to 1938 which states in part that pollution abatement is a subject ". . . of major importance and one which should receive continuous study of the same type as is applied to safety work and fire prevention."

We point out that the company's total investment in air and water pollution abatement facilities now stands in the neighborhood of $56 million. We further assure them that no project, including the current one, is approved unless it is certified that waste disposal or treatment facilities are adequate.

In addition, another device has proven very helpful in allaying public fear, in this case, of water pollution. At a number of new plant locations we conduct a survey of marine life in waters adjoining the plant. The survey, conducted by the Philadelphia Academy of Natural Sciences, an impartial organization of high scientific repute, is made during the construction phase before the plant goes on stream. Survey findings serve a number of useful purposes. The data, of course, assist the plant in planning for its waste disposal. In addition, by making the findings available to local water pollution authorities, the plant has an official benchmark of the "before-the-plant" condition of the water should complaints ever make a follow-up survey advisable.

At first it was thought that publicizing the survey would only serve to conjure up the spectre of water pollution in the public mind. Experience has demonstrated, however, that the public accepts it in a far more positive light; namely, evidence of the company's desire to be a good neighbor as far as pollution is concerned. There is never any question of getting full press coverage. Scientists wading around and casting nets in the local stream are off-beat enough to make a good story. Similar reaction has been obtained from vegetation surveys which have been conducted at a number of new locations.

It is impossible within the space limitations of an article of this type to do anything other than highspot a few of the community relations aspects of building a plant in a new community. Just as no two towns are alike, no two community relations programs are ever alike. Approaches must be fluid and geared specifically to meet the needs of a given situation. It is also probably true that no two companies could ever establish themselves in a community in exactly the same way. What works well for Du Pont might not work well for the *XYZ* company.

But this much is certain, a strong community relations foothold will be obtained by the company that recognizes and satisfies the thirst for information that exists during the introductory phase of a project, and by the company that also moves swiftly to define its role in community life. The mechanics by which this is accomplished are incidental.

JOHN A. GRAY
Union Carbide Realty Company

Physical aspects of plant site selection

Progress from drawing board concept to actual property ownership requires evaluation of many significant factors.

THE CHEMICAL PROCESSING industry generally enjoys less flexibility in locating its plants than is true of most other industries. The need for large quantities of good water for cooling and process uses has become a basic factor around which all other plant location factors must be evaluated.

Water will become more important to the processing industry. It has become increasingly clear that state legislatures will enact more restrictions on the consumptive use of water. New plants can no longer dispose of waste effluents in most states until such wastes are treated to meet the requirements that prohibit stream pollution and contamination.

Other basic factors that have an influence on the location of a plant and must be evaluated are the sources and transportation of raw materials, fuel and power, and the proximity to major markets for finished products. Many secondary factors such as air pollution, climatology, labor, and taxes must also be evaluated as they enter into the final plant location studies, even though to a lesser degree for some chemical processing plants.

When the real estate department is given the assignment of selecting a location and ultimately acquiring a site for a new chemical plant, it presupposes that the above mentioned basic factors have been evaluated by the sales, production, and engineering departments when they were determining the economic feasibility of a new plant project. It is equally logical to suppose that their proposal to top management for approval to build a new plant also indicated the general area in which it should be built.

The general area designation can be very broad and might embrace several states. As an example, the search for a location will be more extensive if a plant site on a navigable stream is required so that raw materials, fuel, and finished products can be shipped more economically by barge.

Plant location and site selection studies, and the ultimate negotiations for a plant site, require the undivided attention of personnel experienced in industrial real estate matters and transactions. If this experience is not available within the company, it is highly recommended that plant location and site selection consultants and the services of industrial realtors be engaged. These matters should never be looked upon as though they can be handled by anyone who happens to be available.

Data for new plant project

As the general area has been established, the following steps are suggested so that potential and tentative plant locations can be determined, and the site selected and acquired.

First, the real estate department must become fully informed on the specific requirements for the plant. These data will include:

1. The basic studies and evaluations on water, raw materials, fuel, and markets that influenced the decision to build a new plant and which established the general area for the location of this plant.
2. Quantities of water and electric power required.
3. The production and inventory requirements for raw materials and fuel.
4. Freight rates for rail and water transportation of raw materials, fuel, and finished products.
5. The operating requirements for personnel including the number, experience, and training required.
6. The minimum and maximum limitations on size of plant site.
7. The data on location and plant site required by the engineering department for plant design and layout.
8. The tentative date construction of the new plant will be started.

Second, an accumulation of maps will be required in the studies to reduce the general area to tentative locations within the area. This will include highway, railroad, water transportation systems, and power transmission system maps.

After tentative locations have been selected, topographical and river maps should be added to the file. As the project progresses, property and tax maps, oil, gas, and other geological and natural resource maps should be acquired if they are available. Maps are essential at the beginning and will be increasingly valuable as the project progresses. Also, they will become useful information that should be retained for reference throughout the ownership of the property.

Preliminary office studies

Some of the preliminary plant location studies can be made in the office by indicating the basic factors influencing the location of the plant on a map to illustrate their proximity to each other. This could be a highway map that covers a large enough section of the United States to embrace the sources of raw materials, fuel, and the principal marketing areas for

finished products. After the locations of raw materials, fuel, and markets are noted on the map, the location of navigable streams should be determined and colored for easy reference.

This preliminary step can be accomplished without too much expense, and at the same time it reduces the general area to those locations that merit further study. The relation of railroads to navigable streams should be noted on the map. This will limit the tentative locations still further.

When the areas that have railroads and highways in close proximity to navigable streams have been determined, topographical maps can be introduced into the preliminary office studies. These maps will show more specifically the location of railroads, highway and, in most areas, the power transmission lines in relation to navigable streams. Unsuitable low lying marsh lands and hilly terrain too steep to grade economically will be shown on the topographical maps. These physical aspects may turn out to be limitations that will reduce tentative locations to those to be included in the field trip itinerary. In addition, certain installations and improvements can be noted for checking during field trips to the area.

On site investigations

While there is considerable merit in reducing, by a study of maps in the office, the number of potential sites to be investigated, there is no substitute for actually visiting each area and property under consideration. The proximity of highways, railroads, power transmission lines can then be seen and located upon the ground by speedometer readings. The physical features of the properties can be observed and studied by comparison with information shown on the river maps and the topographical maps. Industrial, commercial, residential, cultural, or recreational improvements can be noted and eliminated from further consideration if their location is not a major factor. Minimum distances for a plant from these improvements should be noted.

Visiting the area will also provide an opportunity to make an on site observation of river and river bank conditions. It is inevitable that river banks cave in on the inside of curves. On the other hand, plant sites located on the outside of curves are faced with deposits from these cave-ins that present silting and other dock facility problems. These conditions are not shown on river or topographical maps. Channels, sand bars, and islands are usually shown on these maps and can be observed in relation to particular properties even though they must be accurately studied and located later because of their strategic importance to dock facilities.

Most of the properties considered for a processing plant are either rural or semi-rural. They may be ancestral homes with a cemetery that may affect the utility of the property as a plant site. Reinterment is a major undertaking; however, the potential value of the plant site may indicate that it be done.

This preliminary field trip should be carefully planned so that enough time will be allowed to study and note the properties and conditions observed. A procedure usually satisfactory for making field observations and notes on a site is to study these notes with the maps, and prepare a memorandum thereon before proceeding to other locations and sites. This is such an important phase of plant location and site selection that it should not be slighted nor rushed. Also, further studies in the office may indicate that additional trips should be made to the field to recheck specific items and to answer questions that have arisen; all of which may have to do with reducing the potential sites to the final choice.

Selection of sites for optioning

The sites meriting further consideration have by this time been tentatively selected in the area decided upon as the best location for the plant. The decision to be made now is which site should be optioned, and if the site selected cannot be optioned, which alternates are to be chosen for optioning. This decision requires an evaluation of the physical features of the property and the proximity of the site to railroad, highway, power transmission lines, and to the river channel.

The physical features of a site include shape of the site in relation to size, topography and elevations in relation to low lying or floodable areas, the elevation of hills and whether they can be graded economically, and the river front and channel with regards to dock facilities and access that must be provided. Most of these observations can be made from the river and topographical maps and the preliminary on site investigations in the field.

Rail accessibility is also one of the most important features of site selection for a chemical plant. First, the proximity of the railroad should be accurately determined for the preferred site. The construction of rail sidings into the plant can be planned in most cases to avoid expensive trestles, cuts, and fills. A preliminary check with the railroad company will assist in site planning, and after options are negotiated, the railroad will furnish plans and estimates of cost to construct switch tracks and sidings for the plant site.

Electric power transmission lines may cross the properties under consideration, but in any event, the cost of getting power into the plant should be checked with the power company.

After the project manager and the engineering department have concurred in the selection of a location and the recommended plant site, a request is submitted to management for ap-

proval to proceed with negotiations to option the properties required. This request should include a description of the property, its location, and physical features with maps to illustrate these points and to show its relative proximity to the river, railroad, highway, power transmission system, and to the nearby communities. Also included should be the estimated cost of the options and the purchase price of the properties required for the plant site.

Optioning plant site properties

When approval to option a plant site for purchase has been granted, a property ownership map should be prepared. The data for this map can be obtained in several ways, and all should be explored. As an example, tax and assessment maps may be available. Also, the railroad and power companies may have prepared such maps in connection with their industrial development programs. The best method is to obtain deed descriptions of the properties from court house records and then prepare a map of the properties from these descriptions. A typical ownership map is shown in Figure 1 and includes a recommended sequence for optioning the eight parcels or tracts so that each option will add acreage that is contiguous. If there are a number of properties required to make up the plant site, options should be negotiated progressively with the central or most strategic property optioned first.

Discreet inquiries may then be initiated to determine the availability of the properties required. There are several approaches to this acquisition phase. First, the chances are that the preferred site is not for sale, at least to the extent it has been listed with a realtor. Second, the local bank with whom connections may be established might be well informed on the status and availability of the properties or the owners' sentiments on selling. The railroad and power company serving the area may already have information on the availability of these properties and would be willing to firm up their information by contacting the property owners. If a direct approach is decided upon, then the company's real estate negotiators may proceed to contact the owners. This direct approach has many advantages.

The general impression that owners will increase the price on their property if they find out that a company is interested in buying is not an entirely true impression. Yet this can and often does happen, especially when a project is given premature publicity. Also there are a few unreasonable owners. These situations are, for the most part, phases of negotiations that experienced real estate personnel can handle. As a rule when the property owner realizes that the negotiator is well informed on local property values, is a good appraiser, is fair, and has the flexibility to look elsewhere, he will more than likely be willing to negotiate on a reasonable basis.

Option agreements

Options should be for a minimum of 90 days, but if more than two properties must be acquired for the minimum plant site requirements, then options should be at least 180 days. This will provide the time required to complete title examinations, survey the property lines, and prepare metes and bounds descriptions for deeds of conveyance. Options must also provide enough time to conduct soil investigations. All options should be prepared and approved as to form by the company's legal department or by local counsel, and in some cases by both because of the peculiarity of local custom and the application of local statutes. In addition to the terms and conditions of the option and the consideration to be paid for the property, permission must be granted to contractors and consultants as agents of the buyer to enter upon the property to conduct boundary surveys, conduct soil investigations, and to complete the necessary site studies.

Whether the option is prepared by the seller or by the buyer is of little significance so long as the terms and conditions are mutually satisfactory and understood. It is very important that the owner understands the provisions of the option. It is often the case that owners of rural or semi-rural properties have traded among themselves without the benefit of specific formal agreements such as requested by companies who plan to spend millions on a plant project. Lacking this experience, they may later have a different interpretation of the terms and conditions that were agreed upon in the negotiations. For this reason it is worthwhile to point out to the owner that he should have his lawyer represent him in all transactions.

All option payments should apply on the purchase price if option is exercised; forfeited if owner has met all

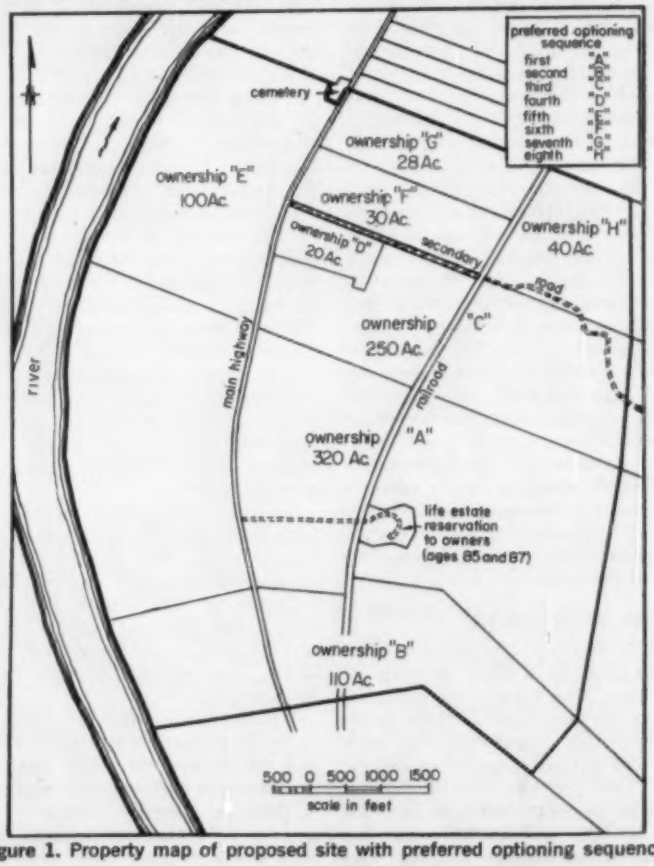


Figure 1. Property map of proposed site with preferred optioning sequence.

option requirements and buyer decides not to exercise the option for any reason. All options properly executed should be placed on record in the county courthouse.

Final site studies

After the options are acquired on the minimum number of properties required for a plant site, much of the physical phase of the work can be carried on simultaneously. The legal department will of course arrange for title examinations. Civil engineers can be engaged to conduct boundary surveys; on site contouring can be started when boundary surveys are completed. If, however, time has become an important factor in getting plant construction started, additional survey crews can be added and contouring can be done without interfering with boundary surveys which must be completed before the descriptions for the deeds of conveyance can be prepared. The time required to complete both of these surveys should be carefully considered because ground cover, swamps and marshes, and brush or undergrowth can greatly affect the progress that can be made by field survey parties. These same obstacles will also materially affect the cost of this field work, especially if extra labor, bulldozers, or other mechanical equipment must be used to clear the lines to be surveyed. Ideally, both boundary and contour surveying can be accomplished more economically when seasonal growth of foliage and vegetation has ended. This opportunity is seldom provided.

Soil investigation engineers can be engaged in the meantime to determine soil characteristics, compressibility tests, piling requirements, and to furnish other foundation data required by the engineering department. This work should be completed in accordance with specifications and on a grid pattern furnished by the engineering department.

Consulting engineers specializing in the design of dock facilities and familiar with the river in the area should be engaged to complete this phase of site studies. Their studies will include normal and abnormal river flow conditions, the cubic feet per second flow under the worst conditions, water temperatures, analysis, and the effects of the highest floods that can be expected. Their recommendations should also include methods of protecting against such floods, and piling and riprapping to protect river banks. In this regard any detailed design or engineering required for specific facilities and installations should be arranged by the engineering department.

All final mapping of boundary surveys and contouring should be done on permanent tracing material using black India ink. These maps should show the locations and types of all easements such as pipe lines, telephone and power lines, poles and towers, railroads and highways, borrow pits, quarries, lakes, streams and canals, encroachments, and buildings or structures of a permanent or semipermanent nature. Both maps should also show the location of concrete monuments or iron pipe property line markers that were installed at all corners, at points of change in the courses along the property lines, and at sufficiently convenient intervals so that one monument or marker can be easily located from another.

The engineer engaged to do this work should be advised at the outset that all basic tracings and maps become the property of the prospective owner and should be submitted to him when this phase of site engineering is completed.

Taking title to property

When the boundary surveys on each property are completed, metes and bounds descriptions should be prepared so that the lawyer may incorporate them in the deed. This survey and deed description will be required by the title company and, if accepted by them and the sellers, it will remain the official description until there is a subsequent reconveyance of any or all of the property.

The deed should be drafted so that both the buyer and the seller may check it before it is put into final form. The final form of deed should be ready for the previously established date for title closing. After title is closed, the deed should be placed on record immediately at the courthouse. Possession of the property may now be taken subject to any conditions of purchase granted owners, such as the right to live upon premises for any length of time, the right to remove improvements agreed to, and to harvest and remove their crops. Obviously such grants to owners during negotiations should first be cleared with management before being made.

After the deed has been recorded at the courthouse and returned, the necessary conformed copies for reports should be made before the deed is placed in the corporate files for safekeeping.

A complete report on the purchase of the property should be made and should include a conformed copy of the deed showing recorded data, maps of the property, contour maps, site and soil investigation studies and reports, purchase price of property, and expenses of purchase. The circulation of these reports will vary from company to company. A suggested circulation might include the finance, tax, and insurance departments; the property and accounting departments; and the engineering and operating departments. A copy should remain with the real estate department, or those responsible for corporate real estate activities, as a working copy with notes of details that are not necessarily included with the copies that are distributed.

Property management

The chemical processing industry has long recognized that there are definite advantages in acquiring larger plant sites than initially required. This practice provides room for expansion when needed at no additional worry or cost; the initial facilities tend to increase the cost of adjoining properties. Also, large plant sites are an added protection when there is an incident that results in an explosion, fire, or the escape of harmful fumes.

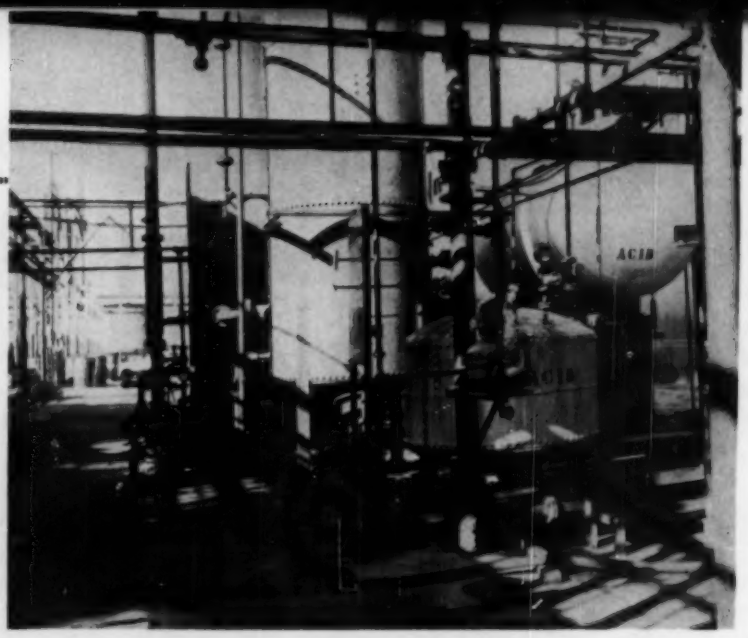
When large plant sites are purchased, some of the acreage not in plant use may be available indefinitely. Agricultural or grazing leases will produce some income and will greatly reduce the expenses of maintaining the property.

The management of such properties should remain with the real estate department of the company until each property has been improved with a plant or facility and the administrative personnel of the plant can take over the management.

Finally, careful plant location planning, evaluations and studies, and site selection by experienced real estate personnel will provide the best assurance that the plant site will have fewer undesirable features that might otherwise become serious economic burdens to future operations.

John A. Gray is a vice president of Union Carbide Realty. Since joining Carbide in 1928, he has held several different posts in the Operating Department at South Charleston, West Va. plant. In 1948, he moved to New York city as assistant manager of the Real Estate Department of the Chemicals Company. He became manager of the department in 1952. Three years later, Gray moved to Union Carbide Realty to become manager of land acquisition and housing. He was appointed to his present post in 1957.

CARL E. LOCKE, MERLE HUTCHISON AND NORMAN L. CONGER
Continental Oil Company



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Anodic protection of process vessels against oleum and sulfuric acid improves product quality, decreases processing time and maintenance costs, extends tank life.

UNTIL THIS YEAR the quest for means of controlling corrosion in the chemical process industry had led to six methods (*2*):

1. selection of more corrosion-resistant materials
2. coatings
3. inhibitors
4. non-metallics
5. design
6. cathodic protection

Anodic protection, can now be added to this list (*3-5*). It is similar to cathodic protection only in that both are electrochemical methods of combatting corrosion. This article describes the application of anodic protection to sulfuric acid corrosion.

What's behind anodic protection

Anodic protection may be briefly described as a method of achieving passivity by electrochemical means. Passivity is a surface condition of a metal that has been rendered inactive to its environment. Passivity may be demonstrated by dipping mild steel in concentrated nitric acid or allowing aluminum to be contacted by air. In both cases, corrosion is halted by the formation of a corrosion-resistant film.

Passivity achieved by anodic currents is described with the aid of Figures 1 and 2. Figure 1 is a schematic diagram of the necessary electrical circuitry. Three electrodes (anode, cathode, and reference) are needed for anodic protection; the vessel is made the anode; an inert metal is used for the cathode; an electrochemical half cell is used as reference electrode. These electrodes are connected to a potential controller.

The potential controller maintains the potential of the anode fixed with respect to the reference electrode by

Table 1. Materials that can be anodically protected.

FLUID AND CONC.	TEMP., °F	METAL	CURRENT DENSITY TO PASSIVATE, MA/SQ. CM.	CURRENT DENSITY TO MAINTAIN, MA/SQ. CM.
H_2SO_4				
1 molar	75	316 SS	2.2	0.012
15%	75	304	0.41	0.071
30%	75	304	0.53	0.023
45%	150	304	175	0.88
67%	75	304	5	0.0038
	75	316	0.5	0.0001
	75	Carpenter 20	0.42	0.00093
93%	75	Mild steel	0.28	0.022
Oleum	75	Mild steel	4.7	0.012
H_3PO_4				
75%	75	Mild steel	40	20
115%	180	304 SS	0.00003	0.00000015
NaOH				
20%	75	304 SS	4.7	0.010
50%	140	Mild steel	0.044	0.133
$Al_2(SO_4)_3$				
Satur.	75	304 SS	0.009	0.0008
Na_2CO_3				
15%	130	Mild steel	0.17	0.017
NH_4NO_3				
Satur.	75	304 SS	0.09	0.0008

Oleum storage tank and blowcase used for measuring acid for sulfonating hydrocarbon.

regulating current flow between the anode and cathode. Potential controller operation is governed by the anodic polarization curve, which is a plot of the anode potential with respect to the reference electrode vs. the current flowing between the anode and cathode.

Figure 2 shows a typical anode polarization curve for the system: stainless steel immersed in sulfuric acid and connected to a calomel half cell through a vacuum tube volt meter. The value of 600 mv found at zero amps current has been defined as the natural corrosion potential for this system. This potential may be shifted toward the noble end of the electromotive series by applying current between the stainless steel anode and an inert electrode as the cathode. The amount of current required to shift the potential increases until a point called the Flade potential is reached. At that value, the amount of current required to shift the potential decreases drastically and remains at this low value until the region labeled "transpassive" is reached.

The potential range above the Flade potential is termed the active region. Corrosion is accelerated in this portion of the curve. In the passive region corrosion is halted, and is accelerated in the transpassive region. Therefore, if the potential of the stainless steel with respect to the half cell is maintained at a value within the passive region, corrosion is halted.

Figure 3 is a plot of weight loss of a 304 stainless steel coupon in 67% sulfuric acid vs. potential with respect to a calomel electrode. This curve assumes the same shape as the polarization curve. The active or accelerated corrosion region is seen as well as the passive region.

What is the mechanism of achieving passivity? Previously, it was said that passivity is a result of the formation of a corrosion-resistant film or layer. Therefore, the applied current must, in some fashion, form an insoluble film or layer. The structure of this film and its formation is subject to debate. There are three main theories *(1)*: (1) iron dissolves and reacts with oxygen to form precipitates of iron oxide which protect the metal from corrosion, (2) oxygen adsorbs on the metal to form a protective monolayer, (3) oxygen is adsorbed and then an amorphous iron-oxygen structure is formed slowly; formation occurs as iron migrates from the base metal into the adsorbed oxygen film.

Electron diffraction patterns indicate that the last theory is probable. Figure 4 is an electron diffraction pattern of a piece of unpassivated 310 stainless steel. The spots and rings are due to the diffraction of electrons by the chromium, nickel, and iron in the stainless steel. Figure 5 is a diffraction pattern of 310 stainless steel after it had been passivated. The lack of any diffraction lines indicates that there must be some sort of amorphous structure at least as thick as the penetration depth (20 Å) of the electrons.

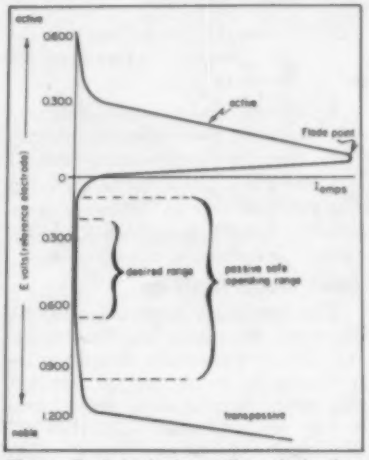

Figure 2. A typical anodic polarization curve.

Figure 6 is an electron micrograph of a non-passivated 310 stainless steel magnified 50,000 times. Note the roughness of the surface. The lines are due to mechanical polishing. Figure 7 is an electron micrograph of the same 310 stainless steel after passivation. The surface has been smoothed; the holes were filled or the high spots lowered.

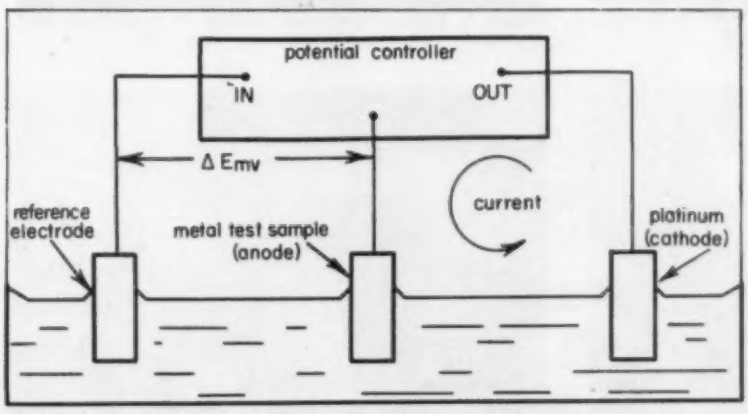

Figure 1. Schematic of electrodes and potential controller relative position.

Determine the feasibility

Before establishing anodic protection in plant applications, the feasibility of this type protection must be determined. This is done by establishing the polarization curve for the metals and environments to be protected. In other words, a polarization curve must be run for the metal in the solution, or solutions, it will be protected from. A weight loss vs. potential curve must be also established.

With information obtained in these two curves, the feasibility of anodic protection may be determined. For

anodic protection to be feasible, the following conditions must be met:

1. the characteristic polarization curve must result.
2. the weight loss in the low-current, (passive) region must be minute or zero.
3. current to maintain passivity must be reasonable and obtainable for large-scale vessels.

Table 1 is a partial list of corrosive systems that can be protected anodically. The list is continually being extended.

Some oleum facilities

The first plant applications to be discussed are oleum handling facilities. Oleum is normally thought to be non-corrosive as it can be handled and stored in mild steel. This is true if you are concerned only with replacement of tanks, piping, and pumps. An oleum storage vessel will last many years under normal operation. However, iron-content data taken when oleum was retained in a mild steel pipe illustrate that oleum does dissolve iron. The iron content of oleum stored in a mild steel pipe for 24 hr. increased from 83 to 119 ppm. Other examples: in a 5000-gal. storage tank, the oleum averaged 600 ppm iron; in a 35,000-gal. storage tank, the oleum had an average iron content of 460 ppm. Iron in solution creates processing difficulties and lowers product quality. Therefore, protection from oleum corrosion can be extremely valuable.

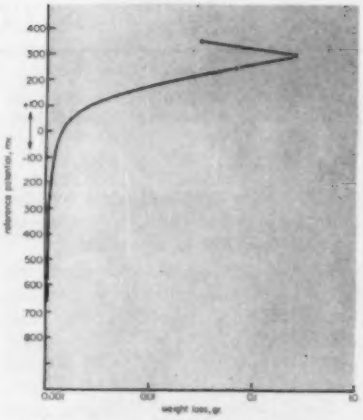

Figure 3. Effect of potential on weight loss of 304 stainless steel exposed 1 hr. to 67% H_2SO_4 at 75°F.

Pictured on pages 50 and 51 is a 5000-gal. oleum storage tank and blowcase under anodic protection. These were the first two oleum vessels to be protected by a plant installation of anodic protection. Both vessels are protected by one potential controller. An automatic switching mechanism connects each vessel to the controller in sequence. The retention time of the passive film in oleum is extremely long, which makes this type switching possible.

The oleum from these vessels is used in a sulfonation process. The iron content of the oleum contained in these vessels had been as high as 1200 ppm, Figure 8. After one week of plant operation, in which fresh oleum was added to the tank under anodic protection, the iron content had reduced to 39-41 ppm (the iron content of the oleum as received from the manufacturer.) These tanks, as shown on the graph, have been protected for about two years.

Anodic protection has also been installed on 10,000 and 35,000 gal. mild steel vessels. The 10,000 gal. tank is

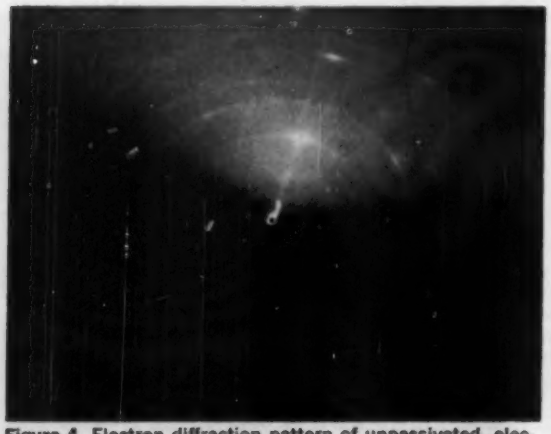

Figure 4. Electron diffraction pattern of unpassivated, electrolytically polished 310 stainless steel. 4X.

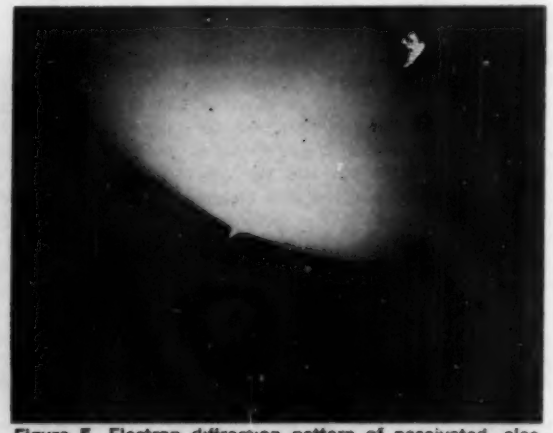

Figure 5. Electron diffraction pattern of passivated, electrolytically polished 310 stainless steel. 4X.

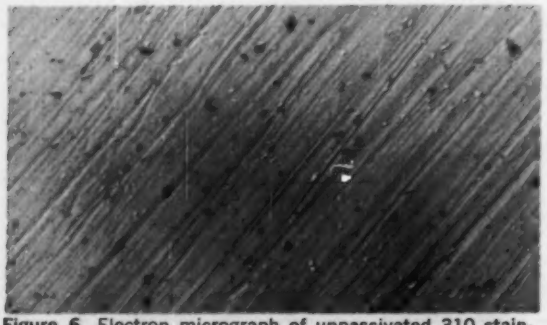

Figure 6. Electron micrograph of unpassivated 310 stainless steel. 50,000X.

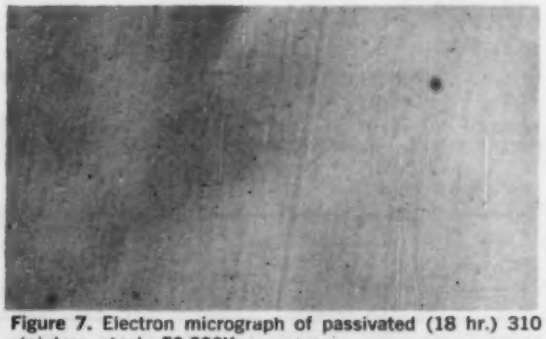

Figure 7. Electron micrograph of passivated (18 hr.) 310 stainless steel, 50,000X.

used as a measuring tank, while the other is used mainly for storage. These vessels are also protected by a single controller. Table 2 illustrates the average iron content in these tanks before and after establishment of anodic protection. The iron content was about 460 ppm prior to protection and was reduced to approximately 72 ppm. Oleum is received in this plant containing approximately 70-90 ppm iron. Therefore, anodic protection is maintaining the iron content at the level as received from the manufacturer.

An oleum transport trailer has also been successfully anodically protected. This trailer is used to transport oleum and sulfuric acid for one particular plant. Originally, the trailer was protected only while it was parked in the plant. It was used as an auxiliary storage under these conditions. The trailer now has a potential controller installed on it. This controller is battery-powered for protection during transit and is connected to plant power while parked in the plant.

Table 2. Iron content of oleum stored in tanks 526 and 527 at Gretna petrochemical plant.

BEFORE PROTECTION	
Oleum as Received	
Average of 8 Samples	53 ppm
Oleum Used After Storage in Plant Tanks	
Average of 8 Samples	460 ppm
AFTER PROTECTION	
Oleum as Received	
Average of 14 Samples	69 ppm
Oleum Used After Storage in Plant Tank	
Average of 16 Samples	72 ppm

Table 3 is a listing of oleum iron content for several trailer loads. The iron content is being held very close (within experimental error) to that as-loaded. This means that the iron content of oleum stored in the plant (if stored in an anodically protected tank) can be lowered even further.

Table 3. Iron content of oleum transported in truck.

Oleum unloaded from trailer while protected in plant	*Oleum stored in trailer using portable unit*
29 ppm	31 ppm
28 "	29 "
26 "	28 "
26 "	27 "
50 "	27 "

The data in this table were taken when the trailer was protected in the plant and after the instruments were installed on the trailer. This further illustrates the long retention time of the passive film in an oleum environment.

Figure 9 is a schematic diagram of a 55-gal. Type 304 stainless steel oleum drum under anodic protection. This drum is used to store oleum for laboratory use. Standard sulfonate samples are mixed from this oleum so the iron content must remain at a constant value. Prior to anodic protection oleum stored in this drum increased in iron content from 45 to 100 ppm in 24 hours. Table 4 lists the oleum iron content of the drum before and after protection.

The electrodes installed in all the vessels discussed to this point were similar, Figure 10. Platinum-clad

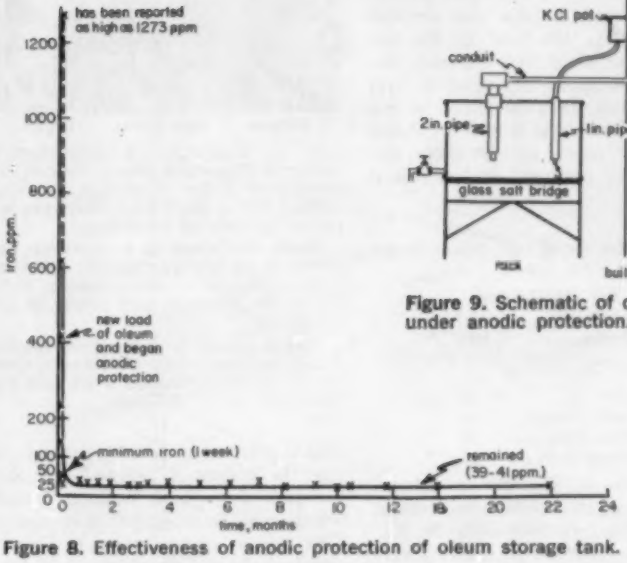

Figure 8. Effectiveness of anodic protection of oleum storage tank.

Figure 9. Schematic of oleum drum under anodic protection.

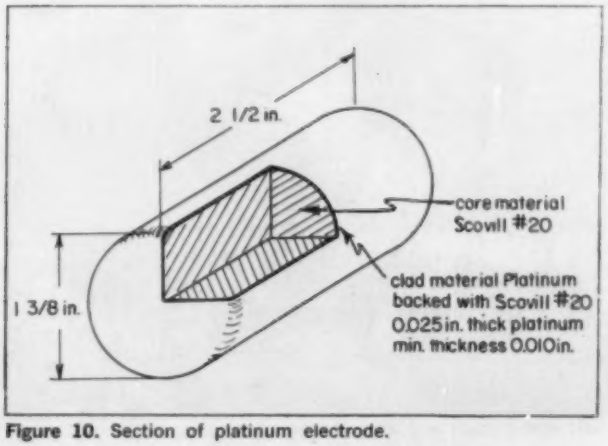

Figure 10. Section of platinum electrode.

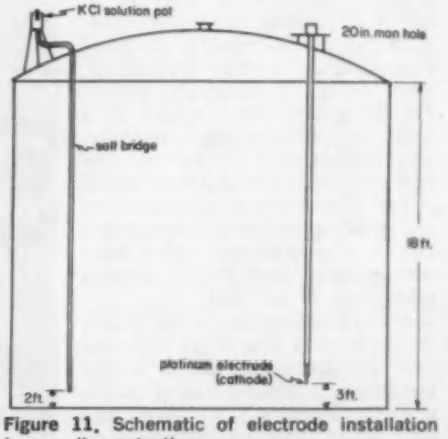

Figure 11. Schematic of electrode installation for anodic protection.

brass was chosen because of platinum's inertness and good electrical properties. Other metals are also suitable provided they are inert in the environment in which they are used. The platinum electrode mounting is constructed from the same metal as the tank in which it is installed. Teflon is used for spacers and insulators because of its electrical and chemical inertness.

Table 4. Iron content of oleum stored in stainless steel drum.

NO PROTECTION	
As Loaded	40 ppm
24 Hours Storage	+100 "
PROTECTED	
As Loaded	45 ppm
One Week Storage	34 "
Two Week Storage	36 "
Three Week Storage	39 "

In oleum applications a calomel cell, in conjunction with a salt bridge, is used as the reference electrode, Figure 11. The salt bridge allows a very low flow rate of salt solution into the oleum, and thus establishes a conductive path for the calomel cell immersed in a salt solution reservoir.

Figure 12 is a photograph of a sulfuric acid storage tank and two blowcases of mild steel containing 66° Be (93%) H_2SO_4. Anodic protection was installed in these to lower maintenance cost. The two blowcases are old tanks with riveted seams, which were continually springing leaks under the 90 lb./sq. in. ga. operating pressure.

Iron data obtained after the installation of anodic protection indicated that these tanks were being protected. Prior to the installation, leaks around rivets in the seams were repaired at least once a month. After five months of anodic protection, there were no leaks to be repaired.

The cathode used in these tanks is exactly like the one described in the oleum applications. A solid silver-AgCl half cell was used as the reference electrode in these applications. Silver chloride is cast around a silver rod, machined, and mounted in a Teflon cup. This electrode has been very satisfactory in H_2SO_4 use. Unfortunately, AgCl is soluble in oleum.

Two process vessels have also been successfully protected by this method. One is a neutralization vessel lined with stainless steel. Figure 13 is a photograph of this tank.

A brief description of the batch process is given here to aid in discussion of the unusual features of this installation. A 20% solution of caustic is first pumped into the vessel and then cooled. After cooling, a sulfonic acid is pumped in. During this pumping, the system is agitated and also pumped through a cooling system which contains about 300 ft. of piping. This process system presents a wide range of pH and temperature.

Conger Hutchison Locke

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The phenomenon allowing this process vessel to be protected under such wide extremes is an overlapping of polarization curves. Figure 14 shows this overlap in the passive region. The polarization curves of caustic and sulfonic acid overlap over a 100 mv potential range. As long as the potential is maintained within this range, corrosion can be prevented. Any number of combinations of solutions and metals can be protected in one system as long as this overlapping effect is present.

The amount of iron picked up during the process before and after anodic protection is shown in Table 5. Notice that the iron pickup has been halted. Therefore, even in a process vessel used in a complex batch operation, anodic protection has been successful in halting corrosion.

The other process vessel now protected is a 2000-gal. sulfonator used to make a long chain sulfonic acid. An aryl-alkane is pumped in and cooled prior to addition of 100% H_2SO_4. Agitation, settling, and wash cycle follow. The most difficult problem encountered in this installation was the low conductivity of the process streams. Both the hydrocarbon and the sulfonic acid have very low conductivities. The input power to the vessel had to be tripled to obtain the current necessary to maintain anodic protection.

The sides and bottom of the vessel are constructed of Allegheny-X metal (similar to Carpenter 20). Cooling coils and agitator are of 304 stainless steel. In this case too, the overlapping of the polarization curves of these two metals allows the tank to be anodically protected. Since 1952, there have

Table 5. Iron analysis of yield in sulfonation plant.

Sample Date	Batch	Total Iron, ppm In Charge	In Yield
	Before protection		
10/10/57	X-216-217	30	230
11/1/57	X-218-219	24	240
2/3/58	T-192-193	55	310
	After Anodic Protection		
5/20/59	X-155-156	20	19
7/23/59	X-210-211	19	16
8/3/59	X-230-231	17	20

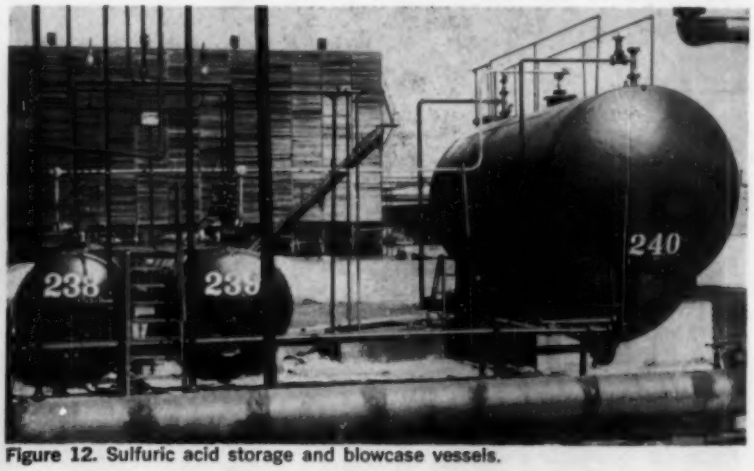

Figure 12. Sulfuric acid storage and blowcase vessels.

been three of these $50,000 sulfonators installed in this particuar plant, indicating the severity of corrosion encountered before protection.

Table 6 gives a comparison of thickness measurements made on two identical sulfonators. The unprotected sulfonator lost metal over all the shell while the protected one did not lose any noticeable amount. The striking feature is that the vessel was protected for five months of the year's time between measurements.

All of the above description of plant applications illustrated the protection of tanks and reduction of corrosion obtainable by anodic protection. Only in cases of prolonging the life of a vessel is this type of data sufficient in itself. There must be some other method of proving the effectiveness of anodic protection. This next section discusses examples of such data.

Table 6. Thickness measurements on stainless steel sulfonators.

Not Protected Measurements, in.		Protected Measurements, in.	
1959	1960	1959	1960
0.180	0.170	0.205	0.205
0.195	0.170	0.210	0.215
0.170	0.165	0.195	0.200
0.180	0.170	0.175	0.175
0.190	0.180	0.180	0.180
0.185	0.160	0.175	0.175
0.185	0.160	0.180	0.175
0.190	0.165		

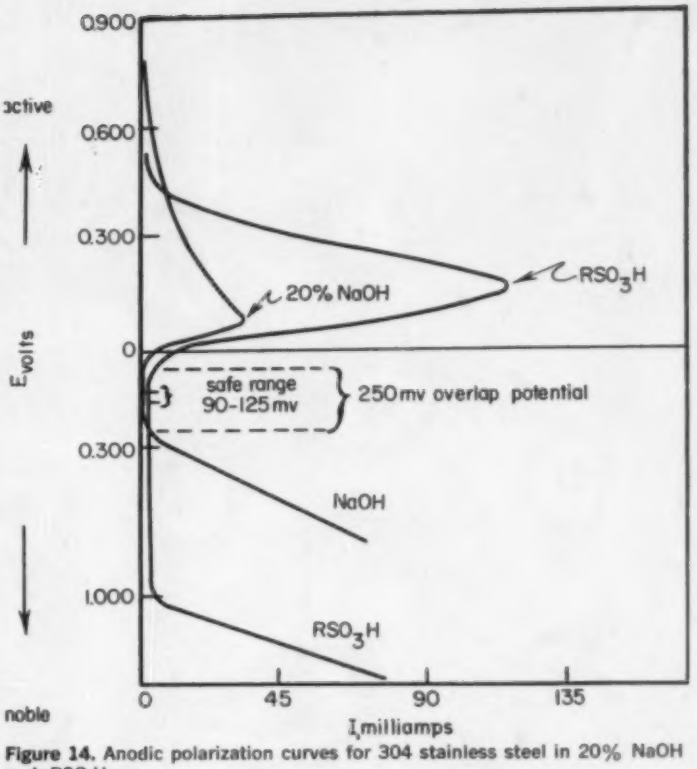

Figure 14. Anodic polarization curves for 304 stainless steel in 20% NaOH and RSO_3H.

Evaluation of anodic protection

The transport trailer, 5000 gallon oleum storage, oleum blowcase, and neutralization vessel described are parts of a sulfonation plant.

Prior to anodic protection, the product was loaded with a fluffy white flocculent matter. There was a heavy layer of cuff due to iron "soap" emulsions. After anodic protection had been installed, the product was clear and free of flocculent matter. The plant went from producing a product that was hard to sell to one that was hard to produce enough of to satisfy demand.

The reduction in cuff, formed at the interface of hydrocarbon and product, resulted in a higher quality product and lowered settling time. The settling time with a large amount of cuff was 14 hr., while with the lowered amount it is two hours. This, therefore, increased plant capacity by reducing processing time. There is less product lost now due to the decrease in cuff. There is a sharper interface and therefore the separation can be made easier.

The possibilities for the use of anodic protection for improvement in product quality due to a reduction in iron content are very promising. There are many processes where iron contamination is a problem: the food industry, pharmaceuticals, synthetic fibers, and many others.

Reduction in maintenance, ability to use a lower alloy metal with protection than is possible without, and extension of vessel life will also be fruitful uses of anodic protection.

The application of anodic protection in chemical process plants is currently being extended and will surely have a tremendous use in the coming years.

Figure 13. Neutralizer tank used in manufacture of sulfonate.

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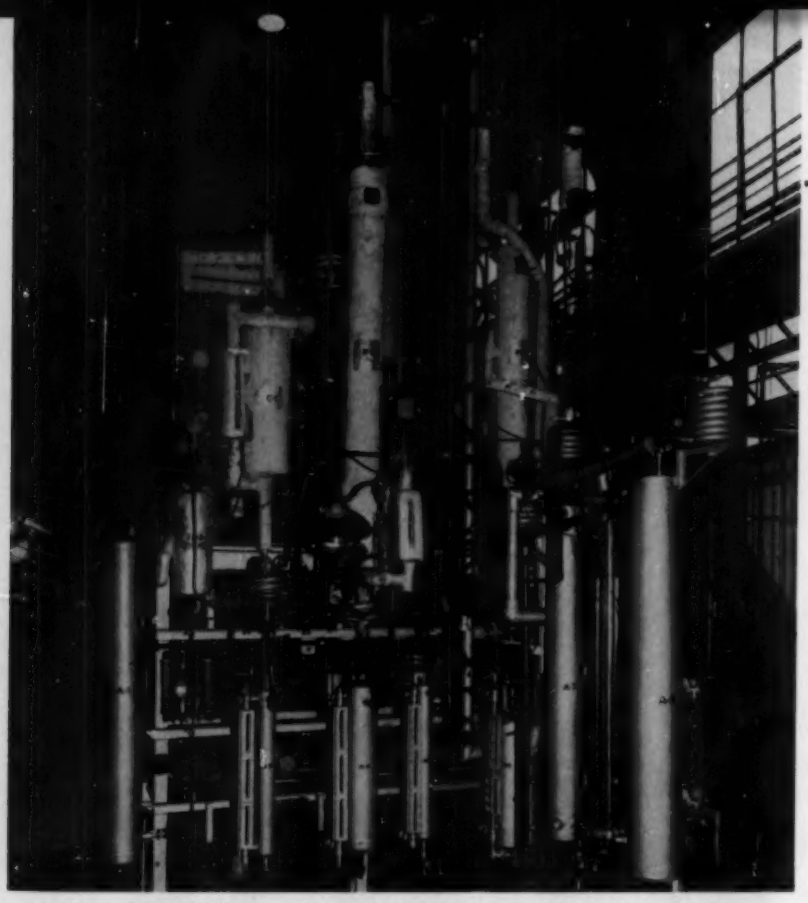


An Esso Standard Oil pilot plant typical of those using designed experiments.

JESSE M. CARR, JR.
AND E. A. MCCRACKEN
Esso Research Laboratories

Statistical program planning for process development

Reduce process development time by fractional factorial design to determine effects of variables.

STATISTICAL PROGRAM PLANNING in process research and development comes into full usefulness at the stage in which the potential process is being transferred from exploratory research to process development. Up to this point the background and intuition of the investigator should guide the day-to-day planning rather than allow "designs" to dictate these decisions.

Statistically designed experiments have not been found to be very satisfactory in exploratory research. The designs frequently call for experiments at conditions known by the investigator to be of little interest, and also limit freedom in day-to-day planning to an undesirable extent. This is not unusual since in exploratory research a very large field is being investigated rather than a small section of a response surface. Statistical program planning becomes increasingly applicable as the problem is narrowed to a response surface and the detectable differences in the product become small in relationship to experimental error. This is usually the beginning of intensive studies in process development.

On transferring problems from exploratory research to process development there is usually a long list of new variables added to those already investigated. It is quite a challenge to determine the effects of the new variables in the shortest possible time or the least number of experiments. The success of a process development program frequently depends upon the speed with which useful answers are produced. Poorly planned experiments can make drawing of useful conclusions from the results difficult.

In process development, experiments should be conducted in small groups which have been designed to answer specific questions, yet will pro-

duce results that will be useful in further studies. Large experiments may be efficient in a statistical sense, but frequently they are not from the standpoint of rapid convergence on useful answers. An investigation involving process development may be divided into three phases: screening, empirical, and theoretical. These phases may be entirely separated from one another, or they can be completely related.

Screening for key variables

Good strategy requires that all of the possible variables be screened initially and those which are not important eliminated. Highly fractionated factorials can be used as a basis for designed experiments to eliminate the unimportant variables. These designs are not new and were known as early as 1935.

F. Yates proposed a scheme for examining seven factors in eight experiments (*1*). Yates's design, shown in Table 1, requires that there be no interactions between variables, since if interactions do exist, they are confounded with the main effects. The design is a 2^{7-4} fractional factorial design or a 2^3 factorial with main effects *D*, *E*, *F*, *G* confounded with the *AB*, *AC*, *BC*, and *ABC* interactions. In Table 1, if *A*, *B*, and *C* are considered the main variables of a 2^3 factorial, then $D = ABC$, $E = AB$, $F = AC$, and $G = BC$. The generating relationship becomes

$$I = ABCD = ABE = ACF = BCG$$

By multiplying these generators in all possible ways, *i.e.*, one at a time, two at a time, three at a time, and then four at a time; the following complete defining relationship is obtained:

$$I = ABCD = ABE = ACF = BCG = CDE = BDF = ADG = BCEF = ACEG = ABFG = ADEF = BDEG = CDFG = EFG = ABCDEFG$$

The defining relationship is then used to determine which main effects and interactions are confounded with each other, in the literature referred to as aliases. To obtain the quantities with which a main effect is confounded, the defining relationship is multiplied by the main effect. For example, the defining relationship becomes

$$A = BCD = BE = CF = ABCG = ACDE = ABDF = DG = ABCEF = CEG = BFG = DEF = ABDEG = ACDFG = AEFG = BCDEFG$$

when multiplied by *A* with all A^2 terms dropped. If it is assumed that the three factor and higher interactions are not important or very small in their effect, then

$$A = BE = CF = DG$$

Thus, the main effect of *A* cannot be distinguished from the two factor interactions shown. Similarly, the confounding of all other main effects yields the following:

$$B = AE = CG = DF$$
$$C = AF = BG = DE$$
$$D = CE = BF = AG$$
$$E = AB = CD = FG$$
$$F = AC = BD = EG$$
$$G = BC = AD = EF$$

There are other generating relationships which can be selected. It is possible, using two levels of the variables, to study 15 variables in 16 experiments and 31 variables in 32 experiments if two factor interactions do not exist.

Table 1. Fractional factorial for seven variables.

Experiment	Variables						
number	*A*	*B*	*C*	*D*	*E*	*F*	*G*
1	−	−	−	+	+	+	
2	+	−	−	+	−	−	+
3	−	+	−	+	−	+	−
4	+	+	−	−	+	−	−
5	−	−	+	+	+	−	−
6	+	−	+	−	−	+	−
7	−	+	+	−	−	−	+
8	+	+	+	+	+	+	+

Table 2. The measured effect.

(1) $A + BE + CF + DG$
(2) $B + AE + CG + DF$
(3) $C + AF + BG + DE$
(4) $D + CE + BF + AG$
(5) $E + AB + CD + FG$
(6) $F + AC + BD + EG$
(7) $G + BC + AD + EF$

Table 3. Fold-over design for seven variables.

Experiment	Variables						
number	*A*	*B*	*C*	*D*	*E*	*F*	*G*
1	−	−	−	−	+	+	+
2	+	−	−	+	−	−	+
3	−	+	−	+	−	+	−
4	+	+	−	−	+	−	−
5	−	−	+	+	+	−	−
6	+	−	+	−	−	+	−
7	−	+	+	−	−	−	+
8	+	+	+	+	+	+	+
9	+	+	+	+	−	−	−
10	−	+	+	−	+	+	−
11	+	−	+	−	+	−	+
12	−	−	+	+	−	+	+
13	+	+	−	−	−	+	+
14	−	+	−	+	+	−	+
15	+	−	−	+	+	+	−
16	−	−	−	−	−	−	−

If the design is analyzed, the main effect *A* will be in fact the sum of the main effect plus the two factor interactions indicated by Equation 1 in Table 2. Therefore, these designs are not particularly interesting from a process study standpoint, as almost always two factor interactions can be expected. On analysis one would wonder if the effect seen was the main effect, a two factor interaction, or various combinations of the two. The total effect could be near zero if the values and signs were such that they cancelled upon summation.

Box and Hunter (*2*) as well as Youden (*1*) propose that the two factor interactions be separated from the main effects by replication of the eight experiments shown in Table 1, but with opposite signs as shown in Table 3. These designs are called "fold-overs" because the pattern of signs in the column are reversed after the eighth experiment.

Using the principles applied to the fractional factorial in Table 1, the generating relation for the first eight experiments of this factorial is

$$I = ABCD = ABE = ACF = BCG.$$

The effect of changing the sign in the last eight experiments is to change the sign on *I* such that

$$-I = ABCD = ABE = ACF = BCG.$$

Using the methods previously indicated, the estimates for the main effects and two factor interactions for the second set of eight experiments are as follows:

$$-A + BE + CF + DG,$$
$$-B + AE + CG + DF,$$
$$-C + AF + BG + DE,$$
$$-D + CE + BF + AG,$$
$$-E + AB + CD + FG,$$
$$-F + AC + BD + EG,$$
$$-G + BC + AD + EF.$$

By adding the two fractions together we obtain:

$$BE + CF + DG,$$
$$AE + CG + DF,$$
$$AF + BG + DE,$$
$$CE + BF + AG,$$
$$AB + CD + FG,$$
$$AC + BD + EG,$$
$$BC + AD + EF,$$

and by subtraction *A*, *B*, *C*, *D*, *E*, *F*, and *G* are obtained. Thus, the main effects are free and clear of two factor interactions. Also of interest is the fact that if the sign of any one column is changed and a second set of eight experiments performed, the main ef-

fect and its two factor interactions will be free of all other main effects and two factor interactions. If, for instance, the sign in the column for the main effect of A is changed as in Table 4 for the second set of eight experiments, but not for the other variables, then the estimable effects are those shown in Table 5.

Another change which can be made to the general case shown in Table 3 is that any letter variable can be dropped without affecting the results of the design. A three factor interaction will appear in the analysis in place of the main effect dropped. Thus, from 4 to 7 variables can be studied in 16 experiments. Box and Hunter (2) also suggest that another variable can be added without confounding the main effects and the two factor interactions. This results in the design shown in Table 6.

Fold-over design application

The fold-over design has been used with success for selecting important variables from a large number of variables. It has been possible also to obtain an indication of the importance of the interactions involving two factors. The experiment used for illustration here has seven variables. The process was known to be operable, yet there was a desire to improve the results of the process as well as determine the effects of the variables. The response measured is the unconverted feed, and it is desirable to reduce this to as low a level as possible.

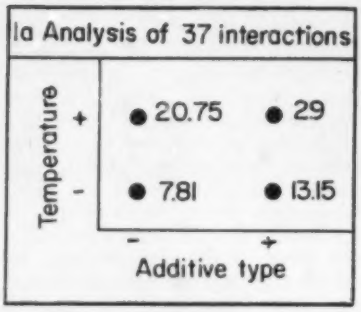
The possible variables were listed and the fold-over design for the seven variables chosen for examination is shown in Table 7.

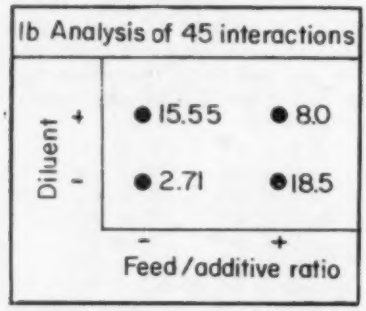
Two types of machines were of particular interest. Machine A had been found to produce desired properties in the product, but Machine B was new and considered to be a better design. The residence time of the material in the system was felt to be important, as well as the temperature. The other variables at one time or another had given indication of being important in determining the properties of the final product.

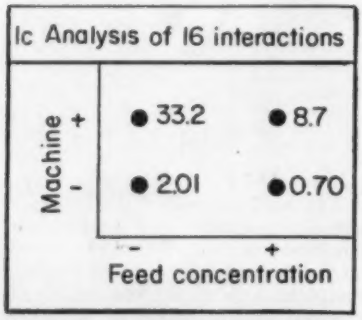
The variables were assigned the levels shown in Table 8. The experiments were conducted in random order for all sixteen experiments. If necessary one could have conducted the first eight experiments, analyzed the data, and then carried out the second eight experiments. Blocking the experiments in this manner to determine if the proper levels of the variables have been chosen is of little value due to confounding of the main effects with two factor interactions.

On analysis of the data it was found that the machine type, feed concentration, and additive type were the most important variables. This was determined from the analysis of variance shown in Table 9.

No variance ratios have been shown in the analysis of variance table since







Figures 1a, b, c. A review of the responses of 37, 45, 16 interactions.

Table 4. Fractional factorial for seven variables.

Experiment number	Variables A	B	C	D	E	F	G
1	−	−	−	−	+	+	+
2	+	−	−	+	−	−	+
3	−	+	−	+	−	+	−
4	+	+	−	−	+	−	−
5	−	−	+	+	+	−	−
6	+	−	+	−	−	+	−
7	−	+	+	−	−	−	+
8	+	+	+	+	+	+	+
9	+	−	−	−	+	+	+
10	−	−	−	+	−	−	+
11	+	+	−	+	−	+	−
12	−	+	−	−	+	−	−
13	+	−	+	+	+	−	−
14	−	−	+	−	−	+	−
15	+	+	+	−	−	−	+
16	−	+	+	+	+	+	+

Table 5. Effects which can be estimated by reversing sign of one variable.

A	BE	+	CF	+	DG
AB	B	+	CG	+	DF
AC	C	+	BG	+	DE
AD	D	+	CE	+	BF
AE	E	+	CD	+	FG
AF	F	+	BD	+	EG
AG	G	+	BC	+	EF

Table 6. Fold-over design for eight variables.

Experiment number	Variables A	B	C	D	E	F	G	H
1	−	−	−	−	+	+	+	−
2	+	−	−	+	−	−	+	−
3	−	+	−	+	−	+	−	−
4	+	+	−	−	+	−	−	−
5	−	−	+	+	+	−	−	−
6	+	−	+	−	−	+	−	−
7	−	+	+	−	−	−	+	−
8	+	+	+	+	+	+	+	−
9	+	+	+	+	−	−	−	+
10	−	+	+	−	+	+	−	+
11	+	−	+	−	+	−	+	+
12	−	−	+	+	−	+	+	+
13	+	+	−	−	−	+	+	+
14	−	+	−	+	+	−	+	+
15	+	−	−	+	+	+	−	+
16	−	−	−	−	−	−	−	+

Table 7. Fold-over design for seven variables.

Exper. no.	Machine type	Residence time	Temp. °F	Diluent type	Feed to additive ratio	Feed conc.	Additive type
1	−	−	−	−	+	+	+
2	+	−	−	+	−	−	+
3	−	+	−	+	−	+	−
4	+	−	−	−	+	−	−
5	−	−	+	+	+	−	−
6	+	−	+	−	−	+	−
7	−	+	+	−	−	−	+
8	+	+	+	+	+	+	+
9	+	+	+	+	−	−	−
10	−	+	+	−	+	+	−
11	+	−	+	−	+	−	+
12	−	−	+	+	−	+	+
13	+	+	−	−	−	+	+
14	−	+	−	+	+	−	+
15	+	−	−	+	+	+	−
16	−	−	−	−	−	−	−

there are no degrees of freedom available for the error mean square. Youden (*1*) has suggested that one set of the eight experiments be replicated to obtain the error mean square, resulting in 24 experiments, but this was not felt necessary. For testing, the error mean square was estimated from the smaller interactions mean square to be approximately 1.00 with 5 degrees of freedom. The critical F at the 95% confidence level is thus 6.6. Although not significant at 95%, the diluent type was considered as possibly an important variable and considered for further testing.

The large mean square for the 16 + 45 + 37 interactions indicated that the data should be reviewed further. To make this review, the four responses at each condition were averaged and plotted as shown in Figures 1a, 1b, and 1c.

After study of the three figures it was concluded that it was quite unlikely that the apparent 37 and 45 interactions were real. The 16 or machine-feed concentration interaction shown in Figure 1c gives a much more reasonable interpretation. This is based on background knowledge of the possible effects of the variables and on the fact that machine type and feed concentration have large independent effects as indicated in the analysis of variance, Table 9.

The conclusions thus can be drawn that a more desirable product can be produced by using the *B* machine, diluent type *B*, 30% feed concentration and additive type *A*.

Table 8. Levels of variables for screening experiment.

Variable number	Variable	Level −	Level +
1	Machine type	*A*	*B*
2	Residence time	1	10
3	Temperature	180°F	220°F
4	Diluent type	*A*	*B*
5	Feed/Additive ratio	100/4	100/6
6	Feed conc.	30%	44%
7	Additive type	*A*	*B*

Table 9. Analysis of variance table for screening experiment.

Variable	Avg. effect	Degrees of freedom	Mean square
Main effects			
Machine type (1)	4.9	1	95.99
Residence time (2)	0.5	1	0.81
Temperature (3)	0.3	1	0.45
Diluent type (4)	1.0	1	4.10
Feed/Additive ratio (5)	0.3	1	0.39
Feed concentration (6)	−3.2	1	41.63
Additive type (7)	−1.6	1	9.63
Interactions			
25 + 36 + 16	−1.3	1	6.36
15 + 46 + 27	−0.1	1	0.03
16 + 45 + 37	−2.9	1	33.61
26 + 35 + 47	−0.9	1	3.60
12 + 34 + 57	−0.3	1	0.31
13 + 24 + 67	0.5	1	1.16
23 + 56 + 14	0.6	1	1.51
157	−0.6	1	1.56
Total	—	15	201.14

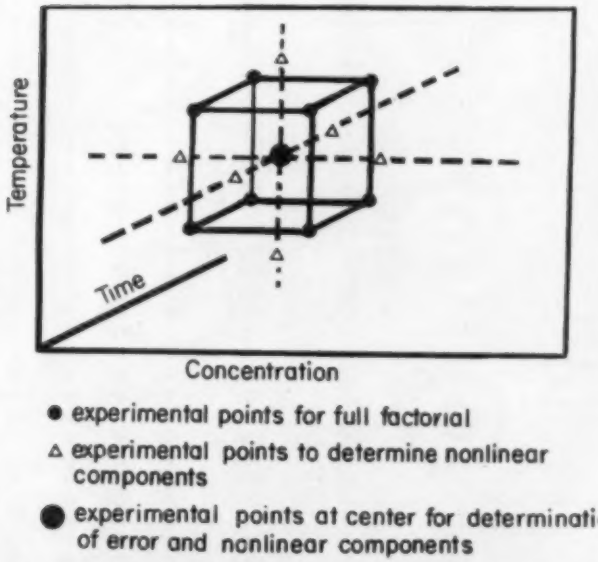


Figure 2. Central composite of experimental conditions for three variables.

Table 10. Fractional factorial for further study of variables.

Experiment number	Machine type	Diluent type	Feed conc., %	Additive type
1	*A*	*A*	44	*A*
2	*A*	*A*	30	*B*
3	*A*	*B*	30	*A*
4	*B*	*B*	44	*A*
5	*B*	*B*	30	*B*
6	*A*	*B*	44	*B*
7**	*A*	*A*	44	*A*
8	*B*	*A*	44	*B*
9	*B*	*A*	30	*A*
10**	*A*	*A*	44	*A*

***Replicates of experiment 1 used for estimating error.*

Follow-up on screening

The next step in process development would be to utilize the information obtained in the screening experiment. For correlation purposes the effects shown in the analysis are only rough estimates of the true effect. This situation is due to the presence of three factor and higher interactions in the average effect value. Thus, it would be wise to determine the effect of the variable per se before making any predictions about the possible resultant products. No predictions can be made concerning the quality of the product outside the operating area used in the screening experiment since the experimental error is only estimated. For these reasons, and the need for producing material for other evaluation tests, additional experiments were planned.

The variables shown to be unimportant in the screening experiment were held constant. The four important variables were used in a ½ factorial design. This design, including two tests to give an indication of the size of the experimental error, is shown in Table 10.

The conclusions drawn from these experiments confirmed previous conclusions from the screening experiment. This statement is made based on the percent unconverted feed as measured in the previous experiment. A second response, a product property, indicated that important product

improvements could be made by using diluent type *B*, the higher feed concentration, and additive type *A*. The machine in this case was not an important variable. Also due to interactions the combination of diluent *B* with the higher feed concentration results in a product better than would be predicted by the separate effects. Analysis of the desirable product property versus the yield of product would be necessary for the final decision of plant operating conditions.

Non-linear response

Fractional factorials such as illustrated have limitations as far as determining the actual relationship of the variable to the response. Two levels of a variable will usually not result in defining the theoretical relationship between the variable and the response. This, however, is not serious since the purpose of the designs has been to indicate that there is an effect of the variable, not to define its actual relationship to the response. A more elaborate design, encompassing at least three levels of the variables, is needed to define a non-linear response. From a response surface study it is possible to obtain information as to the theory or basic mechanism of the process (*4*).

Ordinarily, study of the variables in two levels is quite inadequate because we are interested in the optimum regions for continuous variables such as temperature and contact time. However, if we know theoretically that non-linearities do not exist, then two levels of the variables are completely satisfactory in describing the response to variables.

A three level factorial can be used to define the nonlinear response, however, they can not easily be blocked into a natural sequence for analysis. In addition, usually much unnecessary information is obtained. Easier application of second order designs can be made using the designs of Box and Wilson (*3*) assuming that the response can be represented by the equation

$$Y = b_0 + b_1x_1 + b_2x_2 \ldots + b_nx_n + b_{11}x_1^2 + b_{22}x_2^2 + \ldots + b_{nn}x_{nn}^2 + \ldots + b_{12}x_1x_2 + b_{13}x_1x_3 \ldots + b_{n1}x_nx_1 + \text{Error}$$

A 3^k factorial requires 81 experiments for four variables, while a central composite rotatable design requires only 31 experiments for the four variables and evaluates the equation almost as well as a 3^k design. The central composite rotatable design has been chosen rather than the other designs for response surface study because a center point allows a "standard condition" check of process operation, as well as degrees of freedom for estimating error. This design also lends itself to sequential experimentation.

The usual composite design calls for experiments run at five levels of each variable. An illustration of the experimental conditions required for three variables is shown in Figure 2.

A central composite for five variables consists of the fractional factorial which can be considered as "screening" or fold-over designs for four variables plus star and center points. A complete central composite rotatable design for five variables is shown in Table 11.

Using the first eight experiments of the design as a screening experiment with some center points serves two purposes. First, it allows one to determine if the proper area has been selected for experimentation and second, the replication provides a check of process operation reproducibility. Obviously, if experimental error exceeds the measurable effect of a variable on the response, then little, if any, information can be obtained. This condition would require sharpening of the response measuring "tools" or experimental methods. Sequential experiments often permit determination of answers to the two questions in a relatively short time.

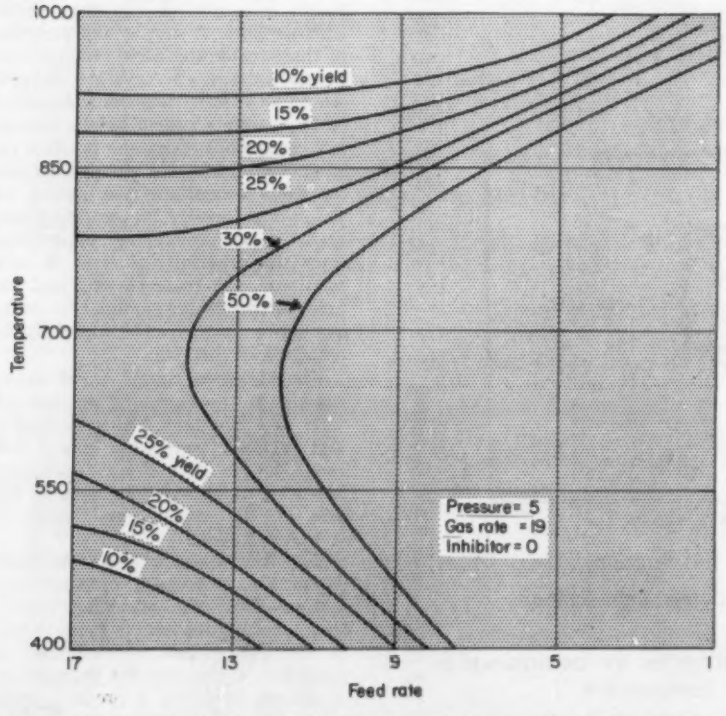


Figure 3. Response surface obtained from central composite design results.

Table 11. Central composite rotatable design for five variables.

Experiment number	X_1	X_2	X_3	X_4	X_5
1	−1	−1	−1	−1	1
2	1	−1	−1	−1	−1
3	−1	1	−1	−1	−1
4	1	1	−1	−1	1
5	−1	−1	1	−1	−1
6	1	−1	1	−1	1
7	−1	1	1	−1	1
8	1	1	1	−1	−1
9	−1	−1	−1	1	−1
10	1	−1	−1	1	1
11	−1	1	−1	1	1
12	1	1	−1	1	−1
13	−1	−1	1	1	1
14	1	−1	1	1	−1
15	−1	1	1	1	−1
16	1	1	1	1	1
17	−2	0	0	0	0
18	2	0	0	0	0
19	0	−2	0	0	0
20	0	2	0	0	0
21	0	0	−2	0	0
22	0	0	2	0	0
23	0	0	0	−2	0
24	0	0	0	2	0
25	0	0	0	0	−2
26	0	0	0	0	2
27	0	0	0	0	0
28	0	0	0	0	0
29	0	0	0	0	0
30	0	0	0	0	0
31	0	0	0	0	0
32	0	0	0	0	0

Carr

McCracken

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Central composite design

An example of this type of experimentation is shown by the design and experimental conditions presented in Table 12. The variable X_4, gas rate, was not felt to be an important variable and did not interact with the other variables. Thus, it was assigned to a column where it would be held constant throughout the first set of experiments. The analysis of variance, Table 13, was the result of the first set of eight experiments plus two center points. One center point experiment was conducted at the first of the eight tests and the second after the last test.

Although no variables were significant using the error term with one degree of freedom from the center points, there is strong indication that x_1, x_2, and x_3 are important. Additional replication would probably provide enough degrees of freedom for the error term to make x_1, x_2, and x_3 significant variables. The variable x_5 causes some concern since the effect, as measured over the range studied, indicates little if any response. This could mean that after a small amount of inhibitor, additional amounts have little if any effect on the response. Thus, there was some doubt that the proper range of this variable was being studied. It was therefore deemed advisable to perform experiments 25 and 26 as shown in Table 12. Experiments thus performed were used to guide further studies of the process.

On completion of the experiments, correlation of the data resulted in an equation which described a response surface. A plane of this response surface is shown in Figure 3. Very interesting inflections are present in this surface and attempts are being made to understand the basic mechanisms of the process.

Table 13. Analysis of variance for first eight experiments of central composite rotatable design.

Source variables	Average effect	Degrees of freedom	Mean square
Main effects			
x_1 (Temperature)	2.75	1	15.13
x_2 (Feed rate)	4.70	1	44.18
x_3 (Pressure)	3.05	1	18.60
x_5 (Inhibitor conc.)	0.70	1	0.98
Two factor interactions			
(x_2x_5), (x_1x_3)	1.45	1	4.20
(x_3x_5), (x_1x_2)	1.30	1	3.38
(x_2x_3), (x_1x_5)	0.75	1	1.13
Total			87.60
Error	—	1	1.00

Table 12. Central composite rotatable design for five variables.

Experiment number	Temperature	Feed rate	Pressure lb./sq. in. gauge	Gas rate	Concentration of inhibitor
1	550	5	5	9	4.5
2	850	5	5	9	1.5
3	550	13	5	9	1.5
4	850	13	5	9	4.5
5	550	5	13	9	1.5
6	850	5	13	9	4.5
7	550	13	13	9	4.5
8	850	13	13	9	1.5
9	550	5	5	19	1.5
10	850	5	5	19	4.5
11	550	13	5	19	4.5
12	850	13	5	19	1.5
13	550	5	13	19	4.5
14	850	5	13	19	1.5
15	550	13	13	19	1.5
16	850	13	13	19	4.5
17	400	9	9	14	3
18	1000	9	9	14	3
19	700	1	9	14	3
20	700	17	9	14	3
21	700	9	1	14	3
22	700	9	17	14	3
23	700	9	9	4	3
24	700	9	9	24	3
25	700	9	9	14	0
26	700	9	9	14	6
27	700	9	9	14	3
28	700	9	9	14	3
29	700	9	9	14	3
30	700	9	9	14	3
31	700	9	9	14	3
32	700	9	9	14	3

Conclusion

Sequential fractional factorials can be used successfully to provide useful answers to a problem without requiring large experimental programs. Use of the results as they become available can be extremely valuable in guiding future studies.

In recommending statistical programs for process development, one must

1. Recognize the value of sequential pattern of investigating a problem.

2. Provide flexibility in the program for changes while giving over-all guidance to the development problem.

3. Provide methods for converging on worthwhile answers in a rapid manner. The risks of overlooking important variables or being misled by experimental error must be balanced against the need to move rapidly and to obtain the necessary information in a minimum number of experiments

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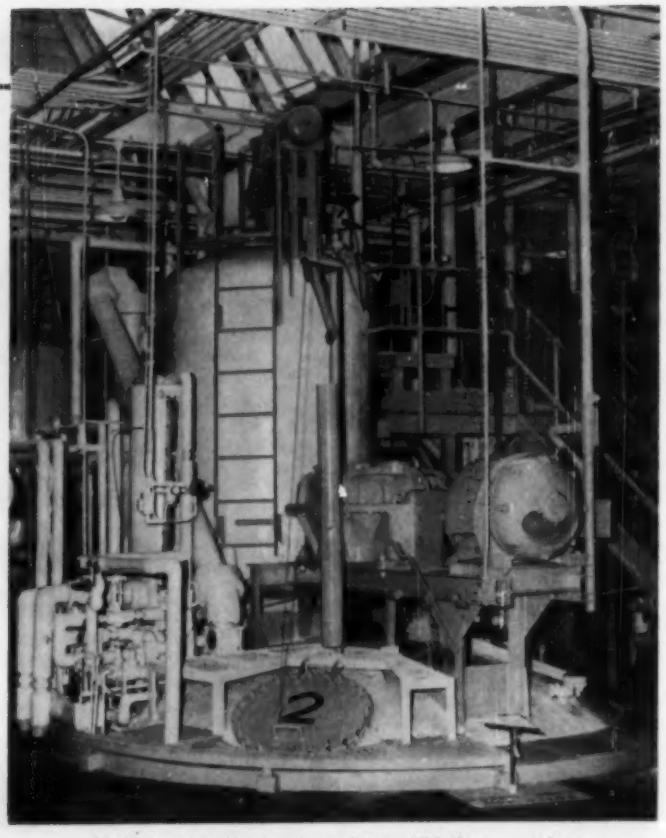
Fitting yield and cost response surfaces



Mold fermentation tank used in antibiotic processing.

Analysis of response surfaces generated by a modified composite design leads to adoption of new plant operating levels netting simultaneous yield and cost improvement.

As WITH MANY OTHER PRODUCTS of American industry, it is quite often necessary to get new pharmaceuticals on the market quickly because of the highly competitive character of the industry and because so many pharmaceuticals are quickly made obsolescent by development of new and better products. Another force compelling fast action is the humane desire to make the life-saving and pain-killing qualities of these products available to the public.

Consequently, the manufacturer's early efforts stress the speedy development of methods to produce a high purity product. Refinements leading to better yields and lower costs are deferred until a later date. This article is simply a case study of the practical problems associated with this later stage of process development. It discusses the application of surface fitting techniques to a typical chemical processing operation. Details of the calculation procedures employed will not be discussed. These are adequately described in a number of standard references, some of which are cited in the bibliography.

Description of the process

Figure 1 is a simplified equipment flow sheet describing a process employed to isolate and purify the desired product, an antibiotic. This process is characteristic of a widely used procedure for separating small quantities of fermentation products from literally tons of inert and impure materials. Each step in the process is designed to eliminate some impurities and to upgrade the product.

It was known that the solvent extraction step constituted one of the most fertile areas for cost improvement in the plant operation because some of the most expensive raw materials used in the process entered at this point, and because the yield was sensitive to proper regulation of the controlled variables.

In this operation, the antibiotic contained in the mash filtrate is extracted into an organic solvent. Reagents *A* and *B* combine with the antibiotic to form a complex molecule which is preferentially soluble in the solvent.

Usage levels of the two complexing agents and the pH at which the extraction takes place were known to have an important effect on yield. Quantitative information on the effect of these process variables was, however, lacking. Historically, it had been found in a number of other processes that most measures which would increase yields were economically justifiable and it was felt that the presence of excess reagent would have no det-

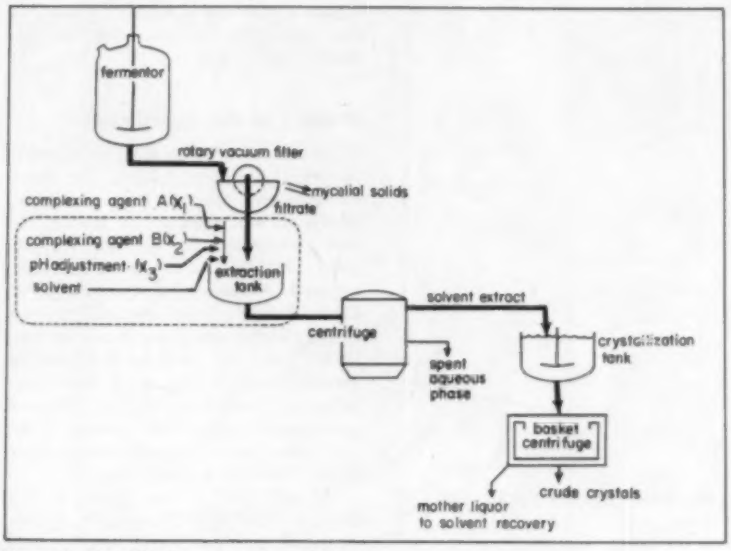


Figure 1. Simplified process flow sheet.

rimental effect on yield. On this basis, the plant operation was designed to operate "a bit on the high side" to insure good yields.

Reasons for statistical study

The plant was under pressure to increase its output of this particular product. There was, therefore, a keen interest in raising recovery levels and in reducing costs by more efficient use of plant and materials.

Although much good information had been obtained on the effect of process vairables, there remained some conflicting theories and unresolved questions about how to regulate the variables in the extraction step. The results of laboratory and pilot plant development work had successfully indicated the approximate levels for satisfactory operation, but they had fallen short of specifying the levels corresponding to a true process optimum. The achievement of this objective had been thwarted by two factors: an inherently large process and assay variation, characteristic of many fermentation processes; and the existence of strong interactions between controlled variables. (This means, for example, that *A* has a different effect on yield at one level of *B* than it does at another level of *B*.)

For these reasons it was decided to undertake a statistical study designed to provide quantitative information on the effect of the important variables.

Design of the experiment

The process was briefly reviewed, and data from previous studies on the extraction step were summarized. All of the variables in the operation were listed and then critically reviewed to eliminate all but the more important ones. Three so-called "key variables" survived the scrutiny. It was agreed to design the experiment around them.

The ranges over which these variables were to be studied were established based on as much process knowledge as was available at the time. An attempt was made to encompass within these ranges the conditions which would correspond to the true yield and cost optima. Ranges were chosen which, it was hoped, would be sufficiently wide to create detectable differences in yield while not exceeding reasonable practical limits.

A 2^3 factorial design seemed to be the natural choice for this experimental situation. It was chosen for the following reasons:

1. The factorial design is an effi-

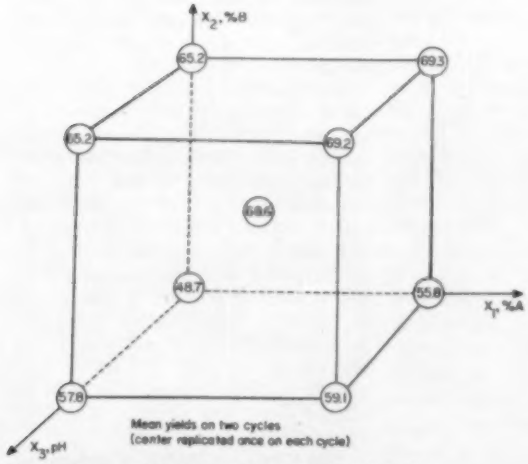


Figure 2. Graphical results of 2^3 factorial design.

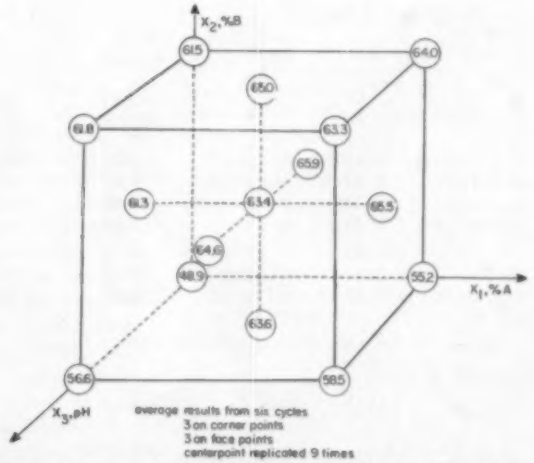


Figure 3. Augmented 2^3 factorial design showing face points.

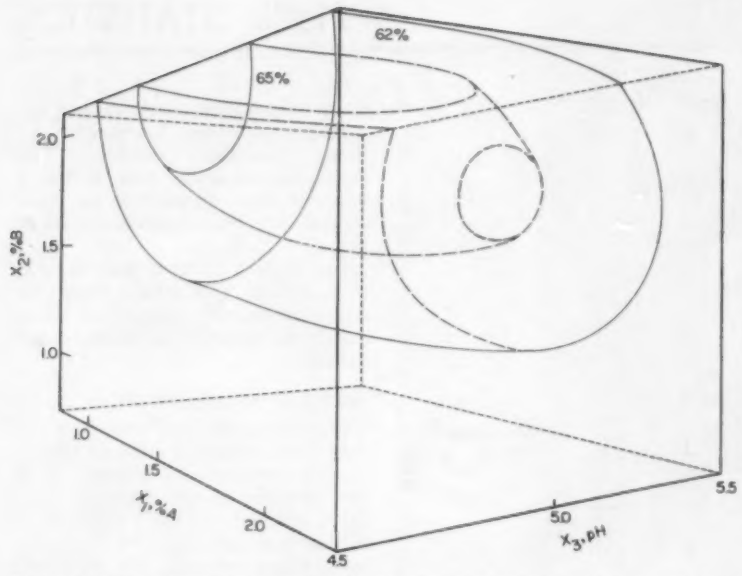


Figure 4. Three dimensional model of yield response contours for 62 and 65% yield.

cient method of experimentation. It provides information on the effect of several variables almost as quickly as a comparable amount of information can be generated on the effect of one variable alone.

2. It provides a measure of interaction between controlled variables if such interaction exists in fact. (A system containing interaction exhibits curvature in its response to changes in levels of the independent variables.) One-at-a-time experimentation would fail to pick up this type of important information.

3. An additional check on the existence of curvature can be provided by adding a center point to the design. The difference between the response at the center point and the mean for all of the peripheral points is a measure of "lack of fit." Lack of fit refers to the inadequacy of a linear model to represent the data.

4. The factorial design can be augmented at a later date to provide an estimate of curvature should it be found to exist. This allows the experiment to proceed sequentially—first with a relatively simple and efficient experimental design, and later—but only if necessary—with one of greater sophistication.

5. The experiment may be kept within a practical size limit by running the treatment combinations in balanced blocks (*1*).

Table 1. Analysis of variance on 2^3 factorial experiment.

Response = % yield (Y_1)					
Source of variance	Sum of squares	Degrees of freedom	Mean Square	*F*-Ratio on Error	Significance of Effect
Total	1188.27	19			
X_1	67.65	1	67.65	2.30	
X_2	562.88	1	562.88	19.20	99%
X_3	37.52	1	37.52	1.28	
X_1X_2	0.01	1	0.01	0.00	
X_1X_3	8.85	1	8.85	0.30	
X_2X_3	39.38	1	39.38	1.34	
$X_1X_2X_3$	7.98	1	7.98	0.27	
	464.00	12			
Blocks	0.00	1	0.00		
Lack of fit	170.47	1	170.47	5.80	95%
Error	293.53	10	29.35		

Prediction equation:

$$\hat{Y} = 62.7 + 4.11\,X_1 + 11.86\,X_2 + 30.63\,X_3 + 0.38\,X_1X_2 + 1.49\,X_1X_3 - 3.14\,X_2X_3 + 1.41\,X_1X_2X_3$$

$$X_1 = \frac{\%A - 0.5}{0.5},\quad X_2 = \frac{\%B - 0.5}{0.5},\quad X_3 = \frac{\text{pH} - 5.0}{0.5}$$

Phase I of the experiment

Figure 2 is a graphical representation of the 2^3 factorial design. The three independent (controlled) variables which it was decided to investigate are represented by the axes of the cube. Distances along these axes correspond to levels of the variables. Each variable was studied at two levels. Three variables, each at two levels, give rise to 2^3 or 8 treatment combinations. Addition of the center point to the design makes 9. These 9 treatment combinations (center point replicated twice) constitute one cycle of the factorial experiment.

As indicated in the figure, it was decided that two complexing agents, *A* and *B*, and the extraction pH would be the subject of investigation. For convenience, these three independent variables will be referred to as X_1, X_2, and X_3, respectively. The terminal values of the range over which they were controlled lie at the corners of the cube.

The dependent (response) variables under examination are referred to as y_1 and y_2, where y_1 is the percentage yield and y_2 is the cost of materials, \$/kg of product.

The numbers appearing in the cube are average step yields corresponding to the treatment combinations represented by their respective positions in the cube. Each value is the average of two individual runs performed in the laboratory. (The magnitude of the numbers has been changed for company security. The calculated effects, however, are those which were experienced.)

Experiments are normally replicated (repeated) several times to provide a reliable estimate of experimental error and to reduce the interference contributed by this source of variation. The size of the measured effects corresponding to changes in the level of the independent variables is compared with the magnitude of the experimental error. If the size of the effect is large relative to the experimental error, it is recognized that the change in yield (or some other chosen response) cannot be due to chance alone. The effect is accordingly considered to be "real."

The formal technique of comparing the size of measured effects with the

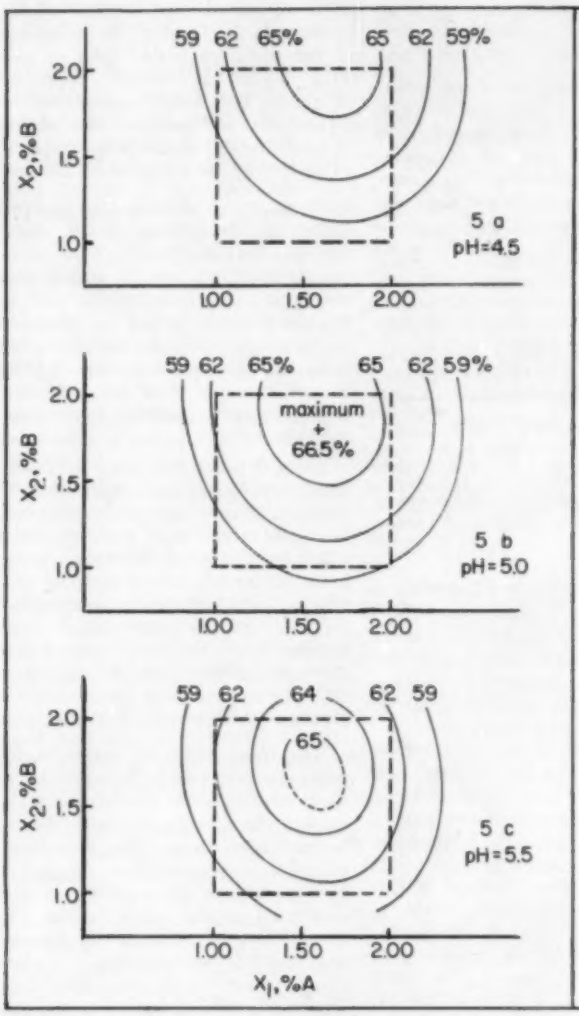


Figure 5. Two dimensional response contours of percent yield (y_1) at fixed levels of pH (variable X_3).

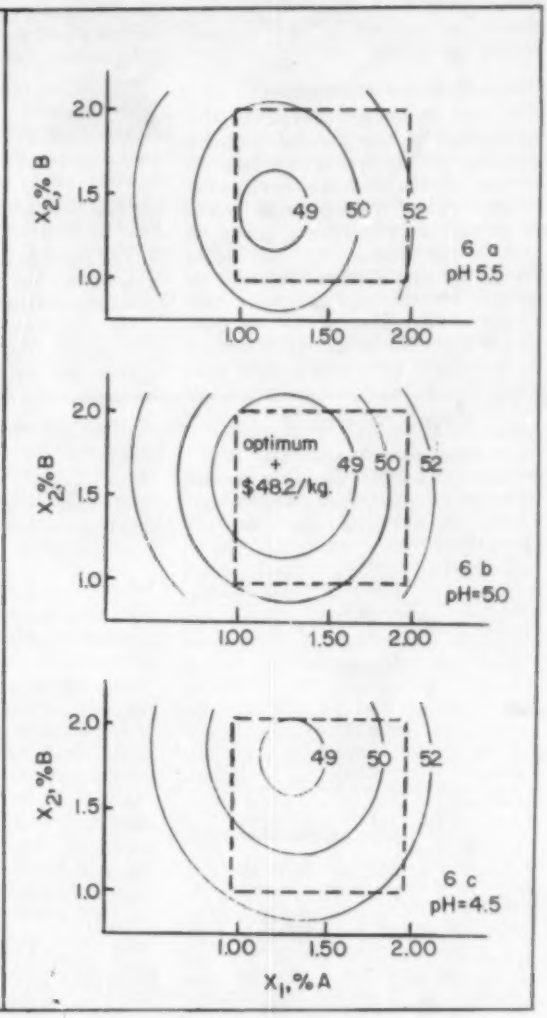


Figure 6. Raw material cost contours, dollars/kg of crude crystals (y_2) at fixed pH levels.

magnitude of the experimental error is called "analysis of variance." Table 1 illustrates the analysis of variance based on two cycles of the factorial design. The response is percent yield. Column 6 of the table lists the probabilities associated with each effect. An effect is considered to be real only if its existence appears to be more than 95% probable.

By inspection of the values in column 6 we learned of the importance of X_2 (complexing agent B). And since the lack-of-fit term was significant at the 95% probability level, we realized that we would have to engage in further experimentation to adequately understand the effect of the independent variables on the system.

Just below the analysis of variance Table 1 is shown the prediction equation derived from the data. As it stands, this is an incomplete second-order equation. The coefficients for the cross-product terms X_1X_2, X_1X_3, and X_2X_3 have been supplied, but those for the quadratic terms X_1^2, X_2^2, and X_3^2 in the general second-order model are missing. These coefficients are normally required in dealing with a system involving interaction. If interactions do not exist, or are relatively unimportant, only the first-order terms in the equation are required.

Prediction equations, as the name implies, are used to predict the response corresponding to various levels of the independent variables. It is safe to apply these equations to conditions within the experimental region. However, caution should be used in attempting to predict the response in regions beyond the experimental limits. Such predictions should be confirmed by obtaining data in these outer regions of interest.

What we have been calling the prediction equation is also known as a regression equation. It was obtained by regressing y against X_1, X_2, and X_3 by the method of least squares (2). It should also be pointed out that the equation given in Table 1 is written in coded form. In performing the regression analysis, the low level of each independent variable was assigned the value of -1 and the high level a value of $+1$. This coding mechanism was used to simplify the calculations. Once obtained in coded form, the equation can easily be trans-

formed to fit the units of the physical system by recourse to the original coding mechanism.

Phase II of the experiment

In our experimental situation, the inadequacy of the first-order model had been proved by the large lack-of-fit term in the analysis of variance. It was evident that we would have to supply additional data points to provide estimates of the coefficients for the quadratic terms. Figure 3 illustrates how the original experimental design was augmented. The new data points (referred to as "face points" on the cube) were added. Note that the design now provides for measuring the response at three levels of each independent variable.

These new data points are called "star points" in a central composite design (*3,4*) and they normally extend beyond the faces of the cube. In this case, however, they were placed directly on the face of the cube for two reasons:

1. The evidence continued to indicate that the process optimum was either within, or very close to, the experimental region already spanned. We wanted to concentrate our data in this region.
2. It appeared that further reductions in the level of the independent variables would take us into a region of sharply depressed yields. This would complicate the analysis and weaken our ability to define the nature of the response in the region of greatest interest.

Three cycles of face points, each including one center point, were run in the laboratory. One additional cycle of corner points was also run. The mean yields for all treatment combinations are recorded in their respective locations on the cube. Each face point and corner point is the average of three individual runs. The center point is the average of nine.

Table 2 shows the analysis of variance on the completed experiment. In this analysis, it was noted that the lack-of-fit term was not significant when tested against the experimental error. It was therefore assumed that the two quantities were independent estimates of the experimental error. On this basis, they were pooled into the "residual" variance, and that quantity was employed in calculating the *F*-ratios for the test of significance.

The three first-order terms in the regression equation (referred to as main effects) were combined for the test of significance as were the six second-order terms. The importance of the second-order effects (suggested by the original 2^3 experiment) was confirmed at this point in the program. It was therefore decided to accept the full second-order prediction equation developed from the data. This mathematical model of the sys-

Table 2. Analysis of variance on 2^3 factorial with face points.

Response = % yield (Y_1)

Source of variation	Sum of squares	Degrees of freedom	Mean Square	"F" on Residual	Probability
Total	2316.91	50			
Linear Terms					
X_1	80.03				
X_2	323.41	3	143.19	3.89	>95%
X_3	26.13				
2nd-Order Terms					
X_1^2	252.25				
X_2^2	51.41				
X_3^2	9.14	6	63.36	1.72	85%
X_1X_2	6.72				
X_1X_3	11.07				
X_2X_3	49.59				
Residual	1507.16	41	36.76		
Lack of fit	101.05	5	20.21	0.52	Not significant
Experimental error	1406.11	36	39.06		

Prediction equation:

$$Y_1 = 65.05 + 1.63\,X_1 + 3.28\,X_2 + 0.93\,X_3 - 2.93X_1^2 - 2.02\,X_2^2 - 1.07\,X_3^2 - 0.53\,X_1X_2 - 0.68\,X_1X_3 - 1.44\,X_2X_3$$

$$X_1 = \frac{\%A - 0.5}{0.5},\quad X_2 = \frac{\%B - 0.5}{0.5},\quad X_3 = \frac{\text{pH} - 5.0}{0.5}$$

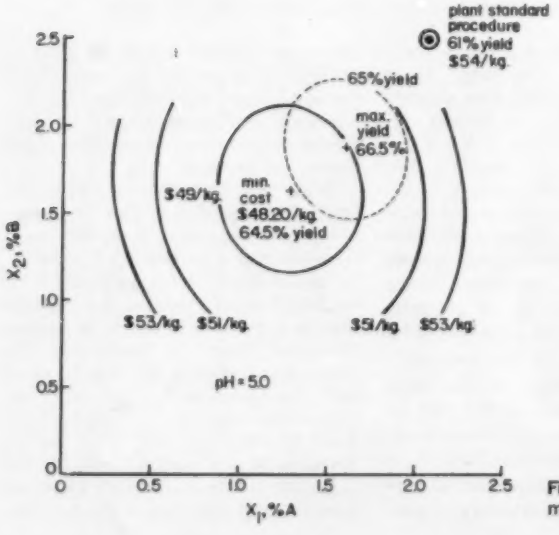


Figure 7. Cost and yield contours at pH=5.0 for raw materials cost, \$/kg (y_2) and yield (y_1) vs. %A and %B.

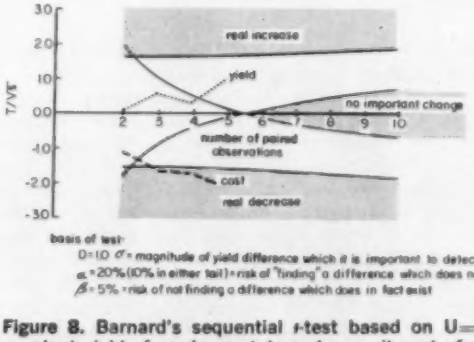


Figure 8. Barnard's sequential *t*-test based on $U = T\sqrt{s}$ on plant yield of crude crystals and on unit cost of crude crystals.

tem is shown just below the analysis of variance Table 2.

Definition of response surface

By analogy with a topographical map, it is possible to graphically represent variations in process yield as functions of certain independent variables. Just as the top of a hill corresponds to a point of maximum elevation, the uppermost portion of a yield response surface corresponds to the point of maximum yield, and the point of minimum cost can be compared to the low point in a valley. For a given process, the coordinates are the respective levels of the independent variables.

It is possible to represent the response of a given process to changes in the levels of two independent variables by drawing lines of constant yield, similar to contour lines of constant elevation. It is also possible to extend this type of representation to three dimensions for three independent variables. For this situation, however, we represent the response by *surfaces* of constant yield rather than by lines. Prediction equations such as those which were obtained in this study are used to generate these so-called response surfaces. The technique of fitting appropriate contours to a process is referred to as "surface fitting."

The time required to calculate a sufficient number of values to plot a second-order model in three dimensions would be prohibitive by means of a desk calculator. However, it can be handled very nicely on a computer. We used an LGP-30 digital computer and calculated a total of 175 contour points to generate the yield surfaces in this study.

Discussion of yield response

Figure 4 is a three dimensional model of the yield response for the process. Two surfaces are shown—one for 62% and one for 65% yield across the extraction step.

When it is realized that every point on a given surface corresponds to a different combination of settings of the independent variables and that, within predictable limits, each of these combinations of conditions produces the same yield, it should be evident that the "fitted surface" is a powerful investigative tool. Almost certainly, some combinations of conditions are going to be preferred to others based on considerations of product purity, cost, equipment limitations, safety, etc. Much of the information required to make a proper selection of operating conditions is effectively displayed in such a model of the system.

Goldin Hickman Lind

Jay Goldin is a process engineer at American Cyanamid's Lederle Laboratories. His current work is on problems associated with commercialization of new pharmaceuticals. With a B.Ch.E., Cooper Union, Goldin has an M.Ch.E. from Brooklyn Polytech.

John B. Hickman is in the production analysis section of American Cyanamid's New York office. He has an M.S. in Ch.E. from the University of Michigan.

Elmer Lind is a process improvement engineer at the Lederle Labs., applying statistical techniques to development and control problems. He has a B.Ch.E., N.Y.U., and an M.S. in Industrial Engineering from Stevens Institute of Technology.

These particular yield surfaces form a family of concentric ellipsoids fitting inside each other. The maximum yield point for the process is at the center of the system of ellipsoids; close to the center of the cube with respect to variables X_1 and X_2 but about 90% of the distance toward the top of the cube (a high level of X_3).

The coordinates of the maximum yield point are obtained by taking the partial derivative of y in the prediction equation with respect to each of the independent variables and setting the derivatives equal to zero, and solving the simultaneous equations which result. The values of X_1, X_2, and X_3 so obtained are then substituted into the prediction equation, and it is solved for y. The value so obtained is the predicted maximum yield (5).

Figure 5 presents some two-dimensional models of the yield response at fixed levels of variable X_3. They can be visualized as having been obtained by taking vertical slices through the cube, Figure 4, at pH levels of 4.5, 5.0, and 5.5 respectively. It will be noted that four yield levels are represented in these drawings. Plotting this many surfaces in Figure 4 would not have been feasible, because of crowding. Instead, attention was directed to the contours of greatest interest.

The three-dimensional model gives a qualitative picture of process characteristics. The two-dimensional models, on the other hand, are graphed to provide quantitative measurements of the relationship between variables. One or both of these methods of representation will, in some cases, provide a clue to the nature of the underlying mechanism.

The predicted maximum extraction yield is 66.5%. The location of this point is shown in Figure 5b. Note that the process appears to be stable in this region. Yields do not drop off sharply as the addition levels of the complexing agents are changed, and they are even less sensitive to changes in pH. This knowledge, combined with the knowledge that materials are important elements of cost, led us to conclude that the economic optimum would be at reduced levels of the complexing agents. It was felt that the reduction in yield caused by a moderate change in this direction would be more than compensated for by reductions in the cost of materials.

The results of the study were reported, but management's response to our proposals was slow in coming. The fault was ours. We had failed to emphasize the value of the proposed changes. It was obvious that savings could be made, but we had not made it obvious that they were worth going after. To stimulate action, it was decided to relate the experimental results directly to cost. We reasoned that the best way to do this was to perform another surface fit—this time employing cost as the response.

Development of cost response

The cost of materials per kilogram of product corresponding to each treatment combination was computed. No additional experimental data were required. It was only necessary to convert the available information on yields and materials usages to cost.

Since all other elements of expense would be approximately constant over the range of conditions imposed by the study, they were neglected. Our interest centered on the *differences* in cost between various treatment combinations rather than on absolute cost levels.

A regression analysis was performed on the cost data, and a new prediction equation resulted. It was used to generate the cost contours shown in Figure 6. These are similar in appearance to the yield contours represented in Figure 5, the principal difference being that the center of this new system is displaced downward and to the left of the center for the yield response.

The point of minimum cost (the economic optimum) is plotted in Figure 6b and again in Figure 7, which is an enlarged view of this family of contours. Superimposed on the diagram is a sketch of the 65%-

yield contour and of the maximum yield point. Also shown is the location of the plant operating condition which was standard at the time that this work was being done.

Figure 7 brings together many useful and interesting pieces of information. It can be seen by inspection the direction in which the plant would have to move to improve both yield and cost structure. The previous concept that adding the two complexing agents in excess has no adverse effect on yield is contradicted. The evidence is that excessive amounts of these reactants actually depress the yield level. Furthermore, it appears that still further reductions are justified by the achievement of a lower operating cost.

The potential value of making certain changes is readily estimated by comparing values on the diagram: adjusting conditions to the so-called maximum yield point, it is predicted, will simultaneously increase the extraction yield by 5½% and reduce materials costs by $5.00/kg of product; alternatively, adjusting to minimum cost conditions will increase the extraction yield by 3½% while effecting a cost reduction of $5.80/kg of product. Either one of these two changes would constitute a major improvement.

Plant reaction to cost response

It was agreed that the laboratory data on which the study was based would probably hold for the plant operation, that scaleup would not alter the effects of the controlled variables. Reaction rates were not of importance, since equilibrium was established well within the limits of the operating cycle.

A second report was issued, this one dealing specifically with the cost response. It was recommended that the plant begin to effect reductions in the use of the complexing agents. To emphasize the importance of the recommended changes, unit costs were converted to estimates of annual savings. The numbers were very impressive.

Publication of this report stimulated interest very quickly. People began to ask questions about how some of the quantities in the report had been estimated. People in the production department began to speculate about how they would effect the recommended changes. Members of management wanted to know "How reliable were the data?", and "How could the results of changes such as those recommended in the report be best followed in the plant operation?"

Evaluation of proposed changes

After some deliberation, it was decided to set up a pulsing type of plant experiment to contrast yields and costs at the predicted yield maximum with yields and costs at the existing plant level. This plan was chosen because it would provide a relatively fast evaluation and at the same time yield an immediate substantial saving if predictions were valid.

Although it was a fairly large change, in terms of materials' usage levels, it was conservative in the sense that it stopped short of the minimum cost point and aimed for the most stable yield region. The fact that it did not go all the way to the predicted economic optimum was not important, since the cost improvement corresponding to the proposed change was about 85% of the predicted maximum. It would therefore give us a substantial cost improvement at the highest level of productivity.

To conduct this experiment without unduly complicating the production operation it was decided to run the plant alternate weeks on *reduced* and *standard* levels of the complexing agents. (Since the plant was already operating at the most favorable pH, there was no need for changing the level of that variable.) In this way, every two weeks of operation provided us with a pair of observations; each pair providing us with an estimate of the effect of making the change. The estimates were pooled as they became available and tested for significance.

Barnard's sequential *t*-test (*2*) was used for the test of significance. Figure 8 shows how the test was performed graphically. It corresponds to what is known as the double-sided alternative hypothesis. This means that the test was set up to detect *either* an increase *or* a decrease in the response at specificed probability levels. The operation of the graphical *t*-test is analogous to the operation of a control chart in that when a point falls outside the boundary lines some form of action is called for.

In the *t*-test, one continues to take observations and to plot their cumulative sum until the first point falls into one of the decision zones (denoted by the shaded areas of the graph). The three alternative decisions which one may arrive at in using the double-sided test are that the change in procedure has produced: a real increase, a real decrease, or no important change in the response.

In monitoring the effect of the recommended change in the plant operation, two responses were followed, percent yield and unit cost. These are shown in Figure 8. The line oriented upward represents the yield response, the line oriented downward, the cost response.

We obtained a total of five observations corresponding to ten weeks of operation. At the end of this time no definite decision could be reached regarding the effect of the change on yield, but it could be safely concluded that the change had produced a real decrease in cost. The cost improvement had actually been shown to exist at the end of three observations.

At the end of the ten week period, some new variables were introduced into the process. As a consequence, the yields which we were using to judge the effect of our controlled changes became highly variable. It therefore became impractical to continue the *t*-test, and the decision was made to adopt the reduced levels of complexing agents *A* and *B* as the new plant standard. The bases for this decision were:

1. The cost advantage of the change had definitely been established. (This was the major consideration.)
2. The indications were that the new levels would provide a yield advantage of several percent.
3. Further application of the *t*-test would, under these circumstances, have been largely academic.

Final optimization of this or any other process is considered to be the responsibility of the operating departments involved. These people are currently employing evolutionary operation (*6*) and various other statistical techniques to help them achieve this objective.

ACKNOWLEDGMENTS

The authors wish to acknowledge the important contributions of John J. Bernardi, Mitchell S. Blicharz, Samuel E. Kaetner, Roger W. Letts, and Robert Winterbottom, all of American Cyanamid Company.

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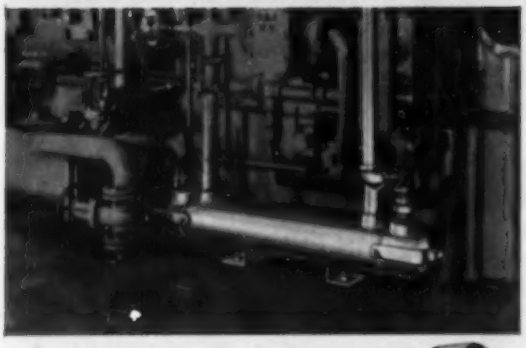
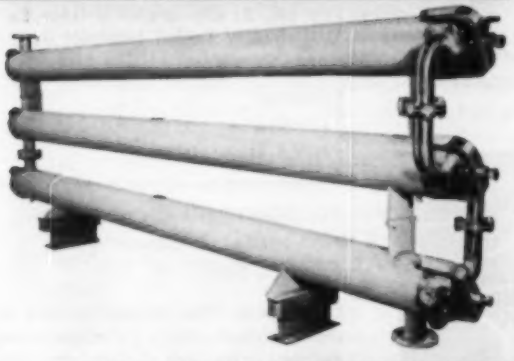
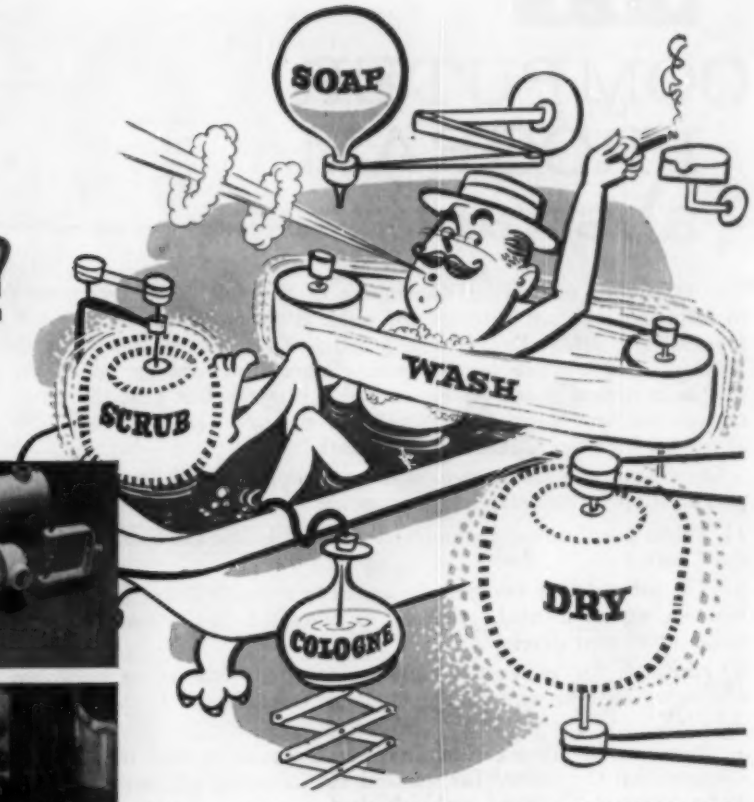
Cleaning Problems?







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CEP

COMPUTER PROGRAM abstracts

The Machine Computation Committee of the A.I.Ch.E. is interested in receiving program abstracts for publication as part of its program interchange activity. Details of this activity are given in the *Guide to Abstracts and Manuals for Computer Program Interchange*, which has just been revised based on experience during the first year the interchange has been functioning. Copies of the new *Guide* are available at no cost from the A.I.Ch.E. in New York.

Once again the Committee wishes to emphasize the three rules for participation in the interchange program:

1) Abstracts submitted for publication must follow the form shown in the *Guide*.

2) The submitter of the abstract agrees to make available for publication a program manual, prepared as described in the *Guide*, should sufficient interest develop.

3) Abstracts for publication, and all questions concerning published abstracts, must be sent to the Machine Computation Committee c/o A.I.Ch.E.

Based on the interest which has been expressed to date, the Machine Computation Committee has selected the following additional manuals to be prepared, reviewed, and published:

Abstract No.	Program	Computer	Contributor
(001)	Shell and Tube Heat Exchanger Rating	Univac I	Dupont
(003)	Orifice Design	Univac I	Dupont
(027)	Solution of the B-E-T Multi-molecular Adsorption Equation	IBM 650	Oregon State College
(053)	Selective Curve Fit	Datatron 205	Celanese Chemical Co.

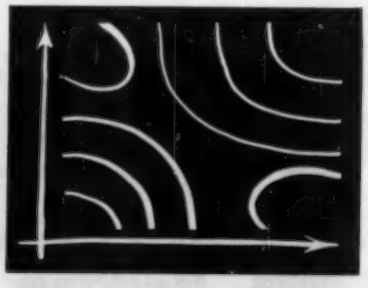
Least squares fit to relaxation equation (050)

Purdue University, Lafayette, Indiana
P. J. Cislak and A. H. Emery

Description: This program calculates the values b′ and c′ which give a least squares fit to the equation, $y = b'(1 - a\,e^{-x/c'})$. The method used is a Newton-Raphson fit to determine c′, up to a given tolerance, with the restriction that the squared deviations be minimized. The program will handle up to 800 observations.

Computer: Datatron 205, 4000 words storage, card input and output, floating point unit.

Running time: Approximately five minutes for twenty observations. This



time is dependent on the number of observations and the initial approximation of c′.

Design of optimum multifactorial experiments (064)

(Plackett and Burman Designs[1])

W. N. Smith and A. W. Umland
The Dow Chemical Company
Process Control Laboratory
Freeport, Texas

Description: The program is used for the statistical design of experiments and/or the analysis of data from these experiments. Either function can be performed separately. For a given number of independent variables, n, to be evaluated by making N runs, a two-level orthogonal design is determined. N must be greater than n and some multiple of four ranging from 8 to 96.

The results of such a design can be

continued on page 72

Machine Computation Committee
A.I.Ch.E.
25 West 45th Street
New York 36, New York

I am interested in computer program manuals corresponding to the following abstracts:

- ☐ **Least squares fit to relaxation equation (050)**
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Check one of the boxes below:

- ☐ **I plan to purchase copies of the manuals checked after they are published.**
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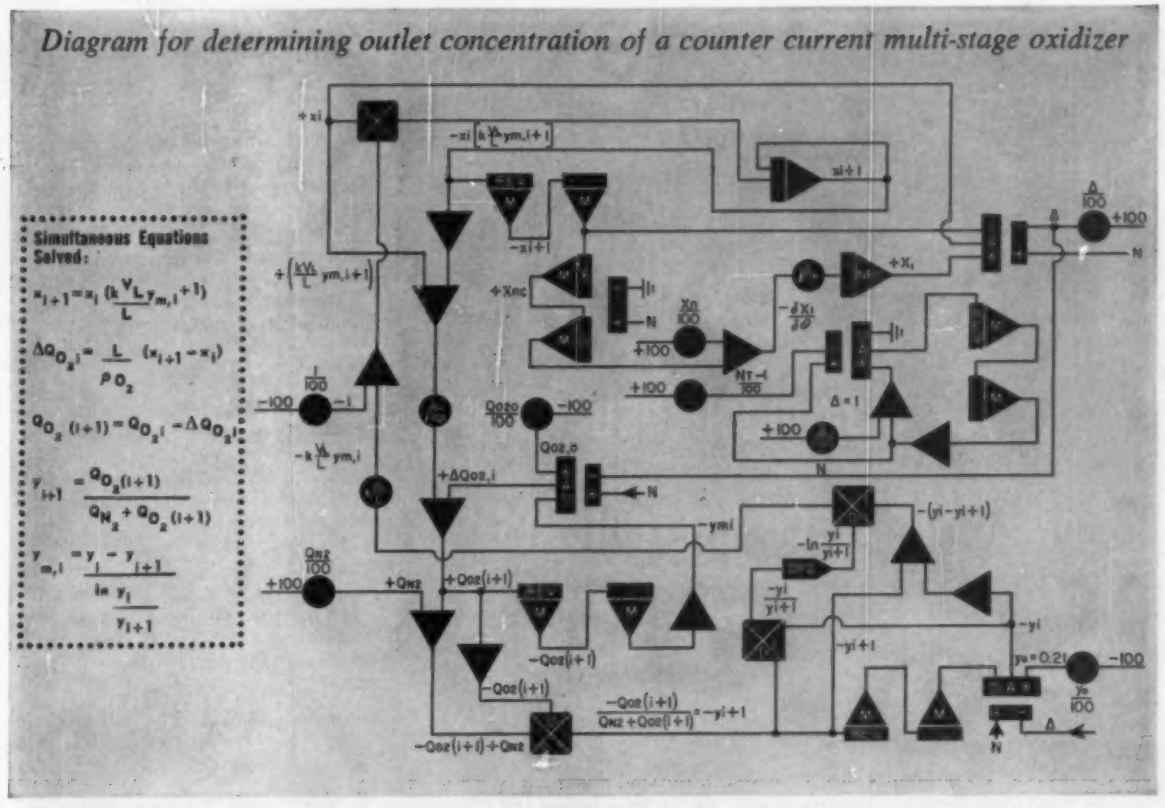
NAME .....
COMPANY .....
ADDRESS .....
CITY & STATE .....

Diagram for determining outlet concentration of a counter current multi-stage oxidizer



Multi-Stage Oxidation Problems Solved in Seconds with DYSTAC Computer!

Dynamic memory and high-speed repetitive operation exclusive with DYSTAC analog computers offer the simplest, most accurate, lowest-cost way of solving multi-stage oxidizer problems. Now, with DYSTAC, any desired specifications can be selected for a given problem. Solutions are achieved at a continuous frequency of 60 cycles per second with an accuracy of ±0.1%. Size of DYSTAC is independent of the number of stages since its dynamic memory permits time sharing of computing elements. Its solution time for a given set of operating conditions is only a few seconds for 10 stages.

Whether your problems are dynamic or static, covering costs, design or production control in: Operations Research, Chemical Kinetics, Structures or Hydrodynamics, DYSTAC can solve them faster, more accurately and more economically than any other computer.

A computer is judged by the problems it solves. Here are some problems which DYSTAC will solve in 20 seconds.

- multi-dimensional partial differentials (steady state or transient)
- sequential, successive solutions for algebraic matrices at 60 to 100 cps
- definite integral calculations
- multiple integrals and partial differential equations . . . or any combination of these problems

Send for detailed report "Counter Current Multi-Stage Oxidation." Learn how DYSTAC *cuts time and costs in solving complex problems that up to now defied either analog or digital computer solution.*

COMPUTER SYSTEMS, INC., Culver Road, Monmouth Junction, N. J. • DAvis 9-2351

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For more information, turn to Data Service card, circle No. 84

Computer abstracts

from page 70

analyzed, listing the effect of changing each independent variable. Those variables found statistically significant are listed separately.

The changes in the independent variables that give the maximum rate of increase of the dependent variable (path of steepest ascent) are readily obtained from the analysis.

The program is based on the method of Plackett and Burman.

Computer: This program (with some modifications) has been written for a Burroughs 205 and also for an IBM 650. The 205 has floating point unit, card reader and on-line printer. The 650 is a basic unit.

Fix-float and square root subroutines are used. An f-table subroutine is used with the 205 program only. (The 650 program ends with the calculation of the variable effects, variable mean squares, and error mean squares.)

Program language: The 650 program is in SOAP I. The 205 program is in machine language.

Running time: Running time varies with the size of the design. On the 205, the program requires 99 seconds to design a 16-run experiment and 61 seconds to analyze the results from 16 runs. The time on the 650 is somewhat longer.

Comments: In the analysis of variance, either 5% or 10% f-table subroutines are available. Also, any number of the variables can be pooled with the error mean square.

[1]Plackett, R. L. and Burman, J. P., *Biometrika*, 33, 305 (1946)

A $7 million nitrate of potash plant will be put up by the Southwest Potash Division of American Metal Climax. Plant location will be Vicksburg, Miss., design, engineering, and construction will be by Jacobs Engineering of Pasadena, Calif.

Are you coming to New Orleans?

Make plans now to attend the Petrochemical and Refining Exposition and National A.I.Ch.E. Meeting in New Orleans from February 26 to March 1, 1961. The program consists of a technical session covering papers of interest to chemical and petrochemical engineers. The Exposition will feature important developments in the field.

Rules for presenting computer data

A.I.Ch.E. committee outlines general suggestions to authors of technical papers on machine computation.

As part of its continuing effort to promote understandability in the publication and use of machine computation data, the Machine Computation Committee of A.I.Ch.E. has formulated a set of general rules for authors and for the editors of technical journals.

Data presentation

Authors are encouraged to present experimental data in terms of a regression equation. Included with each regression equation should be at least one of the several accepted statistical measures of the goodness of the fit. If a regression equation is not presented, then the original data should be tabulated. If a curve in a plot of experimental results has been "fitted" by eye, it should be so stated and, if a least squares fitting has been made, the regression coefficients should be given as noted above. If a plotted curve has been obtained from a theoretical mathematical equation, this equation should be given. Adherence to this recommendation, says the committee, will increase greatly the usefulness of the data, particularly if the data are to be used in extensive calculations.

Computational algorithms

Authors should include a statement, in sufficient detail to be completely understood, of any or all computational algorithms used in solution of the equations presented. This can consist of a listing of the computational steps or a conventional logic flow diagram. This is particularly important when such algorithms have been incorporated in computer programs. It is *not* suggested that computer flow diagrams be included when the computational algorithms are obvious or trivial, but only when they are important for an understanding of how one executes such a calculation, and for interpreting the results properly.

Computer use statement

Whenever an author has employed a computer, it is recommended that a brief statement be included which lists the type and configuration of the computer used, the coding system, and the running time per case. This is a useful guide to those who may wish to employ the calculation method or modifications of it. Its location in the article should be commensurate with its importance.

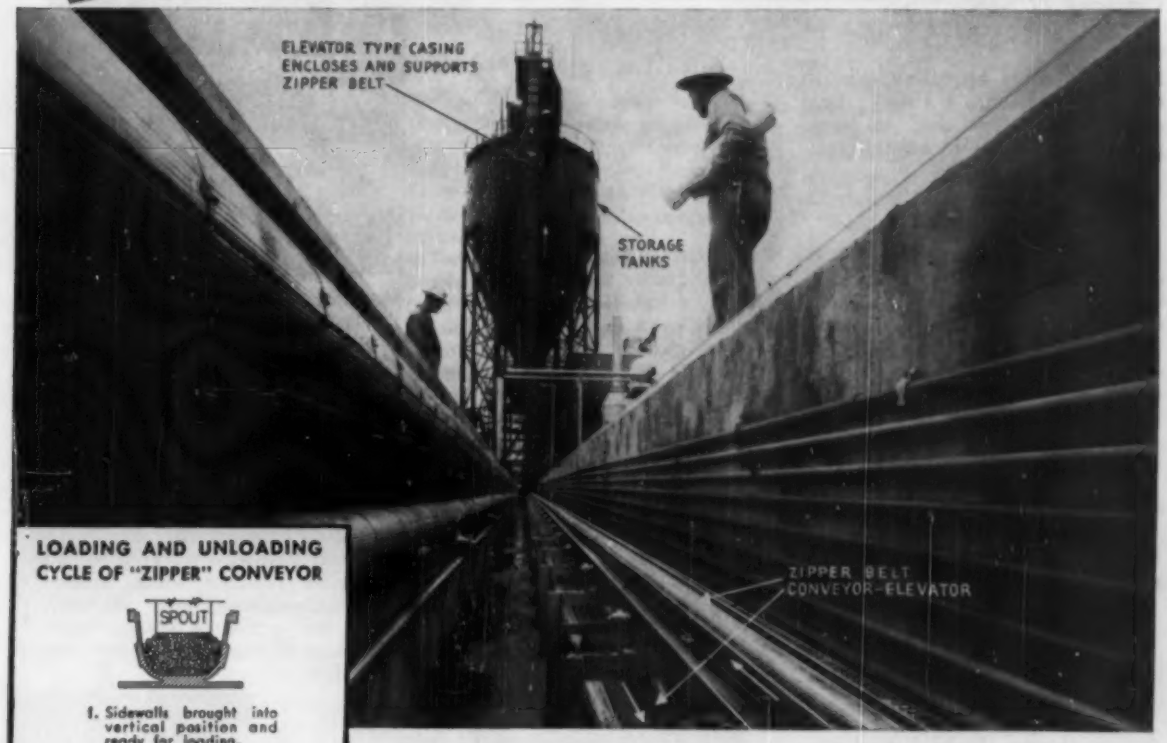
A phosphoric acid plant near completion at National Phosphate, Marseilles, Illinois, is designed by Chemical Construction. The unit will produce 54% P_2O_5 phosphoric acid by the wet process, using 93-98% sulfuric acid.

A new Swiss corporation is part of Tennessee Eastman's research program. Eastman Research A.G., with offices in Zurich, will direct its work toward fundamental research in polymer chemistry and physics, catalysis and in synthetic organic chemistry.

STEPHENS-ADAMSON

EXCLUSIVE

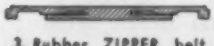
"ZIPPER"* CLOSED-BELT CONVEYOR-ELEVATORS



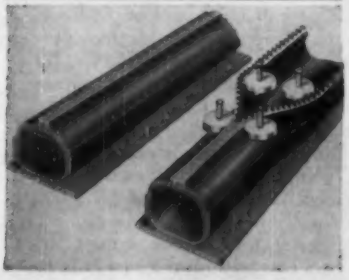
LOADING AND UNLOADING CYCLE OF "ZIPPER" CONVEYOR

1. Sidewalls brought into vertical position and ready for loading.

2. Flexible tube completely closed for conveying and elevating.



3. Rubber ZIPPER belt open for discharge, cleaning and return run.



Upper left unit closed and loaded. Lower right shows how belt is opened and closed by system of ball bearing rollers. (Rollers are mounted on a rigid framework)

CONVEYS AND ELEVATES BY CONTINUALLY WRAPPING MATERIAL IN A PACKAGE... MOVING THE PACKAGE AND ITS CONTENTS TO A NEW LOCATION AND GENTLY UNWRAPPING IT!

Literally a moving material-carrying conduit, the ZIPPER Conveyor is capable of transporting bulk materials in any plane, to considerable heights and around obstructions. Its great advantage is that bulk materials may be conveyed within the belt completely sealed and dust-tight. Material doesn't slide, isn't scooped, pushed or thrown but is gently carried over great distances without breakage, agitation or segregation. The ZIPPER Conveyor-Elevator provides versatility of layout and profitable material handling advantages you won't want to overlook.

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WRITE FOR BULLETIN 349

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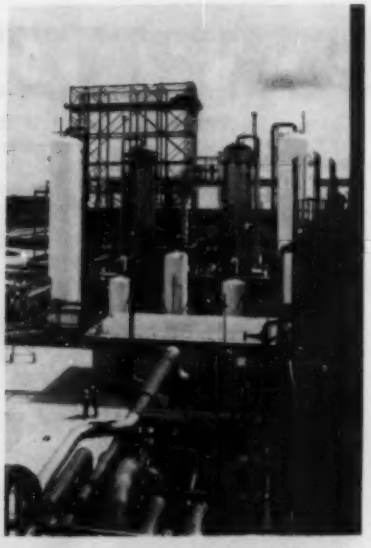
industrial news

Closed-loop computer control called a success

Several months operating experience at Monsanto's Luling, La., ammonia plant is said to have proved out economic advantages.



Monsanto's Barton Plant at Luling, La. Building in center houses the master control room from which the entire ammonia process is regulated by computer.

COLD, UNROMANTIC BUSINESS LOGIC lay behind Monsanto's 1958 decision to install an RW-300 control computer at its Luling, Louisiana, ammonia plant. So far, after several months of operation, all indications are that the investment will pay out handsomely. During the feasibility study which preceeded the purchase of the machine, the computer was purposely regarded as a production tool, rather than a research or development device. Final decision was a management, not a technical one.

How the study was made

Since very little experience with a process control computer is yet available, estimating profit return on such an installation comes down chiefly to an engineering evaluation.

Increased profits by computer control can theoretically be derived from several factors—increased product, reduced cost of production, increased efficiency in use of raw materials, improved quality in the product.

In the case of Monsanto's Luling plant, the capital cost of the installation consisted of the computer itself; a fixed fee for engineering services on the part of Thompson-Ramo-Wooldridge, makers of the computer; and the costs of modifying existing plant process instrumentation and of adding required additional instrumentation. Instrumentation ran into more money than expected. "We more than doubled Thompson - Ramo - Wooldridge's estimate for instrumentation," says Monsanto's Claude Parrish," and the final figures were slightly above even our numbers."

Minimizing uncontrolled variables

Atmospheric conditions — mainly temperature—affect the capacity of producing equipment. By optimizing operating conditions as these variables change, throughput can be improved.

At the Luling ammonia plant, for example, it had been noted for some time that plant capacity was greater in winter than in summer. Even rain squalls or a sudden drop in temperature associated with thunderstorms permitted capacity to be increased.

Data were extracted from past operating records to obtain a relationship between production and temperature. Plotted results indicated a broad array of points generally showing an upward trend with decreasing temperature. A regression analysis on an IBM 704 computer produced a mathematical function which, when shifted up to pass through the maximum points of the previous data plot, gave an indication of the maximum production possible at any temperature. Then, by going back to the temperatures corresponding to the original data, increase in production over the year could be predicted.

Similar analyses were prepared for the other variables which affected yield, throughput, and efficiency, using appropriate factors for error. The sum of these credits was considerable.

continued on page 78

Chlorine—caustic soda production figures

Hitherto unpublished data on world production of chlorine and caustic soda, by areas.

WORLD PRODUCTION of chlorine in 1959 reached a new record of 8.1 million short tons with plants operating at approximately 82% of installed capacity, according to results of a survey made recently by Bert Cremers, vice-president and director of Wyandotte Chemicals. Cremers presented his hitherto unpublished data in Barcelona, Spain, at the 32nd Congreso Internacional de Quimica Industrial. This record production was made in 417 plants operating in 55 different countries.

Caustic soda production also set a new record in 1959, with total world production at 11.4 million short tons, or 79% of installed capacity. A total of 460 caustic soda plants were operating in 56 countries.

Total world chlorine investment, on a replacement basis, is estimated by Cremers at approximately $2.7 billion.

Capacity figures by areas were cited by Cremers in his Barcelona address:

North America—61 chlorine producers have a capacity of 5,528,000 tons, and 61 caustic soda producers have a capacity of 6,520,000 tons.

European Economic Community—67 chlorine producers have a capacity of 1,709,000 tons, and 70 caustic soda producers have a capacity of 2,572,000 tons.

European Free Trade Area—Chlorine capacity of 29 producers is 921,000 tons, and the caustic soda capac-

continued on page 78

Progress Report...

—Chemicals for herbicides

—FLEXOL epoxy plasticizer EP-8

Chemicals for 2, 4-D and 2, 4, 5-T herbicides

Several CARBIDE chemicals are useful in the manufacture of 2, 4-D and 2, 4, 5-T acids and in the formulation of esters and salts for their application.

Phenol and acetic acid are the major organic raw materials needed to produce the acids. The practical use of both 2, 4-D and 2, 4, 5-T depends, of course, upon accessory chemicals that permit them to be emulsified, or dissolved in water, for spraying. The relatively high cost of some solubilizing agents and their poor solubilizing efficiency are problems that have been satisfactorily overcome by the use of CARBIDE chemicals.

Ester Formulations...

Isopropanol, isobutanol, and butanol are favored for converting the herbicidal acids to esters. They combine ease of reaction, low cost, low molecular weight, and ready solubility in light hydrocarbons. To minimize the possible hazards of volatility, "low-volatile" esters of 2, 4-D and 2, 4, 5-T are prepared from 2-ethylhexanol or the glycol-ethers, both of which meet Department of Agriculture standards. For general use, esters of butoxyethoxy propanol are favored.

Emulsifiers of these esters may be a mixture of TERGITOL nonionic NPX and cationic amine 220—or oleates based on CARBOWAX polyethylene glycols. With aliphatic hydrocarbon diluents, a coupling agent such as butyl CELLOSOLVE may be required.

Amine Salt Formulations...

Because of the high potency and volatility of 2, 4-D ester formulations, the safer amine salts of 2, 4-D have found wide acceptance. Another advantage of amine salts is that they can be removed easily from spraying equipment merely by rinsing with water.

Among several amines suitable for formulation of liquid concentrates of 2, 4-D, diethanolamine and triethanolamine are the most economical. Both have comparatively low odor, low toxicity, and low volatility. Preparation of the 2, 4-D salts is done by mixing acid and amine in the proper proportions for combining chemically. Our Technical Representatives can furnish you with information on the advantages of CARBIDE chemicals in formulating 2, 4-D and 2, 4, 5-T herbicides.

New epoxy plasticizer replaces costly materials

A new money-saving epoxy plasticizer, FLEXOL EP-8 (2-ethylhexyl epoxy tallate), is now commercially available. Vinyl resin compounders can use it in place of more expensive materials, such as azelate, adipate, and sebacate plasticizers. This new material has exceptionally good flexibility at temperatures as low as 40° F., as well as excellent light and heat stability.

In addition, as an epoxy, FLEXOL EP-8 provides vinyl products with outstanding resistance to heat. At concentrations as low as five parts per hundred in vinyl compounds, it reacts synergistically to give greater opposition to heat degradation than metallic-stabilized vinyl compounds separately.

For low-temperature compounds, FLEXOL EP-8 can be both plasticizer and epoxy stabilizer with low-cost primary plasticizers such as FLEXOL DOP (di-2-ethylhexyl phthalate).

Among the characteristics of vinyl plastisols produced with FLEXOL EP-8 are low viscosity and good viscosity stability. Vinyl film and sheeting made with EP-8 exhibit exceptional hand and drape.

In calendered film and sheeting, coated fabrics, garden hose, electrical insulation, injection-molded or extruded articles—wherever a combination of low-temperature flexibility and heat-light stability for vinyl chloride plastics is required—EP-8 should have particular appeal.

This compound also is suggested for use as a stabilizer for chlorinated rubber and other chlorinated solvents, and as a plasticizer for nitrocellulose and synthetic rubbers.

Physical properties and other information about FLEXOL EP-8—performance, compatibility, and typical analysis—are contained in a technical bulletin now available from your nearest CARBIDE office, or by checking the coupon.

Tear out this coupon. Check the boxes on which you'd like more information, and mail to Dept. H, Union Carbide Chemicals Company, Division of Union Carbide Corporation, 270 Park Avenue, New York 17, N. Y.

- ☐ FLEXOL Plasticizer EP-8
- ☐ Physical Properties of Synthetic Organic Chemicals—a comprehensive description of the properties and applications of nearly 400 CARBIDE chemicals.

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CARBOWAX, CELLOSOLVE, FLEXOL, TERGITOL and UNION CARBIDE are registered trade marks.

UNION CARBIDE CHEMICALS COMPANY

UNION CARBIDE

For more information, turn to Data Service card, circle No. 64

Computer control

from page 76

No curtailment of personnel

From these credits were subtracted estimated costs—depreciation on the new capital investment, procurement and training of personnel, increased operating costs. Contrary to popular opinion, says Monsanto, such a computer installation doesn't save either maintenance or operating personnel, but increases both.

Who should have a computer?

Success of the Luling operation does not mean that every plant will soon have a computer, emphasizes Grant Russell, manager of Monsanto's Systems Engineering Section. There are, he points out, certain criteria of size and complexity which must be met before a computer is justified. Monsanto's studies indicate that unless a relatively small percentage increase in profit will support the necessary investment, the plant is probably too small for digital computer control. If preliminary studies show that large increases in yield or efficiency are possible, it is likely that these can be effected more simply by conventional engineering changes or merely by better instrumentation.

A $17 million chemical plant complex will be built at the Richmond refinery of Standard Oil of California. The new facilities will increase Richmond's production of paraxylene by 41 million lb./year, will also turn out more than 100 million lb./year of high-purity orthoxylene. Construction is slated to be completed by late 1961 or early 1962.

Du Pont's Central Research Department will put up a new physical research laboratory at its Experimental Station in Wilmington, Delaware. Specialized facilities will be installed for research in ferromagnetism, crystal physics, molecular structure and bonding. Detailed studies of the properties of new materials will also be emphasized.

Chlorine

from page 76

ity of 29 producers is 1,365,000 tons.

Russian Bloc—30 chlorine producers with a capacity of 697,000 tons, and 36 caustic soda producers with a 1,633,000 ton capacity.

Europe (other)—37 producers with capacities of 130,000 tons of chlorine, and 340,000 tons of caustic soda.

Africa—10 chlorine producers have a 34,000 ton capacity, and 10 caustic producers have a capacity of 35,000 tons.

Central and South America—43 chlorine producers with a capacity of 153,000 tons, and 45 caustic producers with a capacity of 255,000 tons.

Asia and South Pacific—64 chlorine producers have a capacity of 648,000 tons, and 88 caustic producers have a capacity of 1,767,000 tons.

End use pattern

An accurate picture of world-wide consumption patterns is very difficult to come by, said Cremers. However, his estimate for the United States is as follows:

Chlorine	
Chemicals	81%
Pulp & paper	15.5%
Sanitation	3.2%
Miscellaneous	0.2%
Caustic soda	
Chemicals	32.4%
Rayon & film	15%
Pulp & paper	11.4%
Soap & cleanser	6%
Petroleum refining	5.4%
Net exports	5.3%
All other uses	19.2%

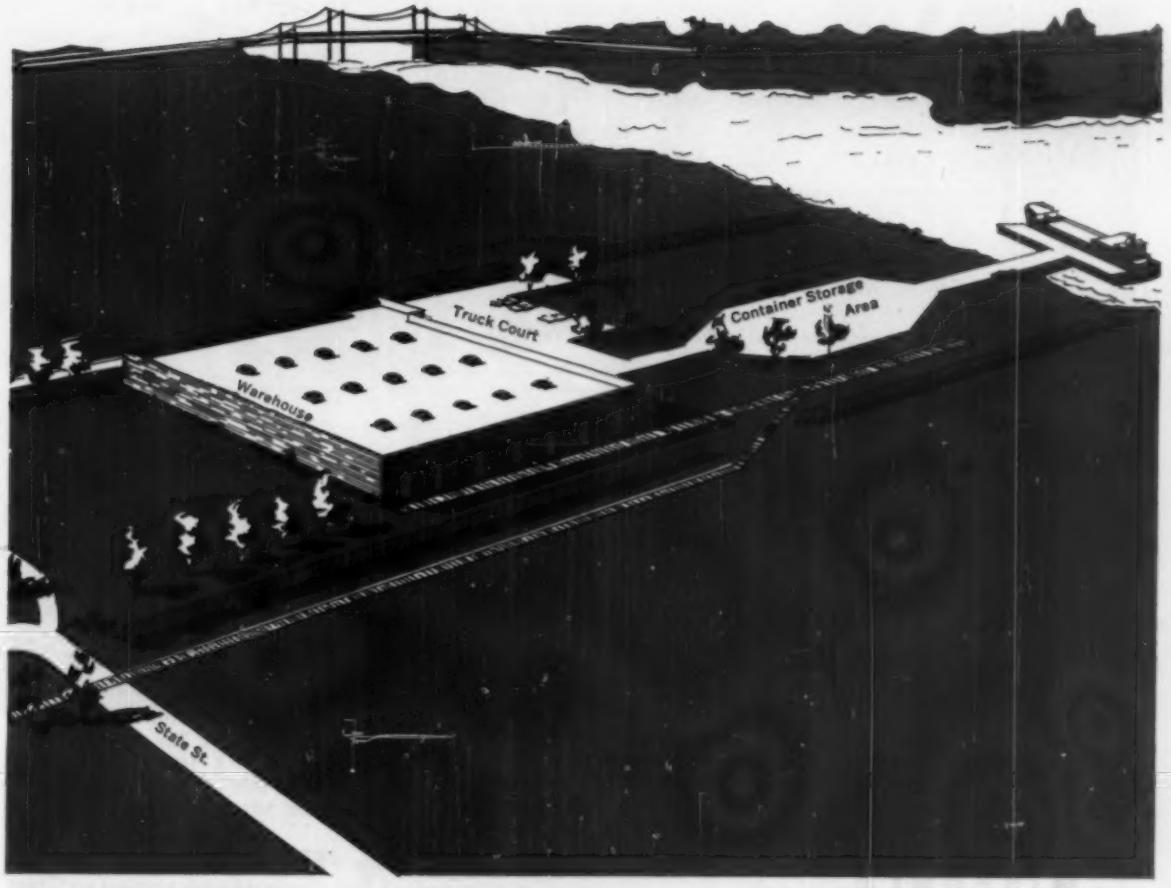
Monsanto Chemical is reported negotiating for acquisition of American Viscose's entire 50% interest in Chemstrand. Plan is subject to approval of both Viscose and Monsanto stockholders.

Benzene shipments will begin by mid-1961 from a new plant to be built by Phillips Petroleum at its Sweeny refinery south of Houston, Texas. Design capacity of the new unit will be 22 million gallons a year.

Ultra-pure titanium trichloride is now in production at a new plant unit just completed by Stauffer Chemical at its Anderson Chemical Division, Weston, Mich. Rated capacity is 500,000 lb. annually.

SPECIALISTS IN SUCCESSFUL PLANT SITE SELECTION

Cushman & Wakefield, Inc., has served as broker and appraiser of industrial sites for some of the nation's largest corporations . . . Union Carbide, Pratt & Whitney, Owens-Illinois, American Can, Eastman Kodak, RCA, Raytheon. The firm's industrial brokerage experts can be helpful both in the location of plants and the appraisal of property for corporate and other purposes.

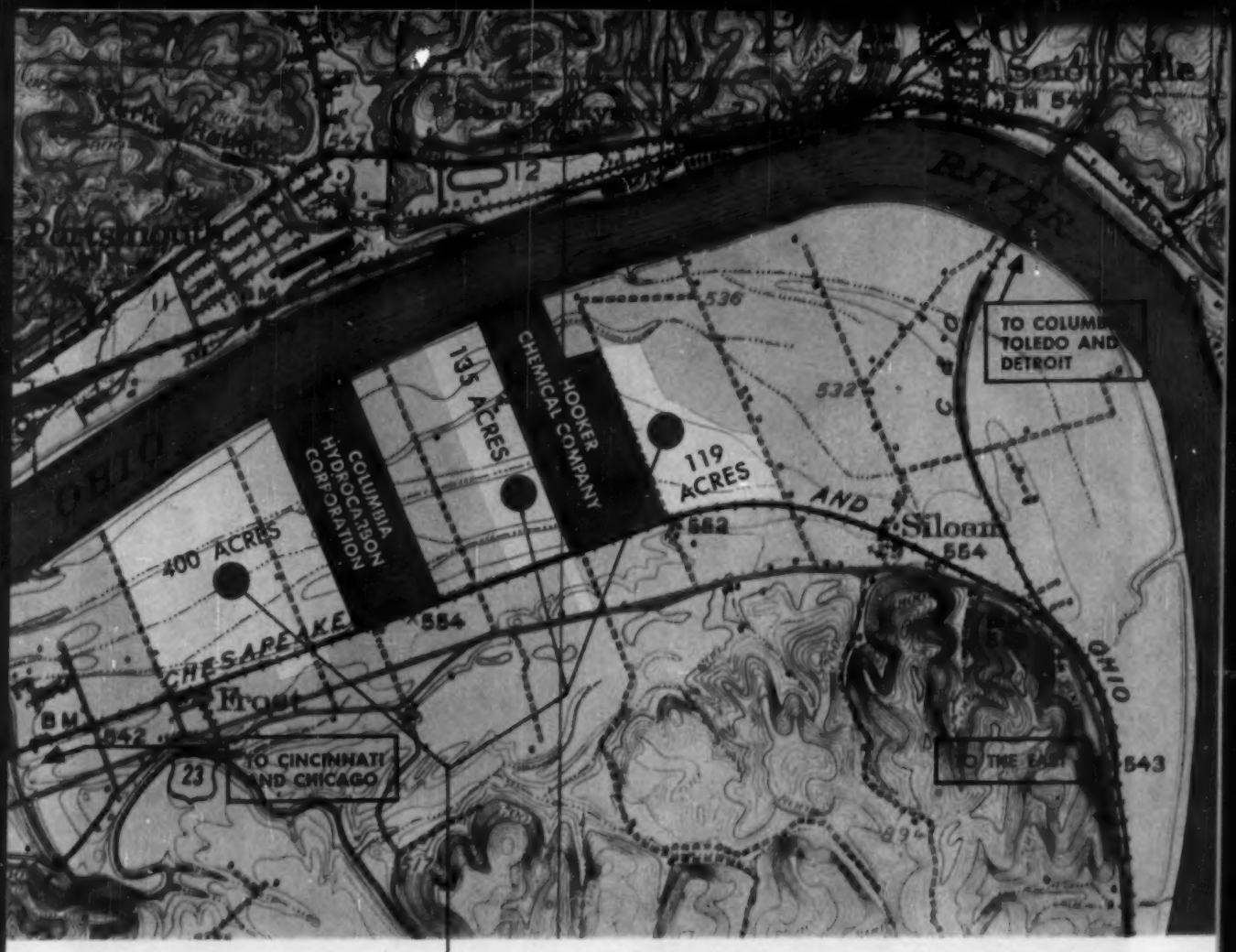


On a site of 106 acres on the Arthur Kill river in Perth Amboy, N. J., Union Carbide will build a marine terminal for plastic resins. Facilities will include a wharf, an approach trestle, a steel-frame building, an office and a shop. CUSHMAN & WAKEFIELD was the broker for the sale of the land to Union Carbide.

CUSHMAN & WAKEFIELD, INC.

529 Fifth Avenue • New York 17, N. Y. • Telephone: YUkon 6-1500

For more information, turn to Data Service card, circle No. 111



AT SILOAM, KENTUCKY

three plant sites for ethylene users

The recently completed fractionation plant of the Columbia Hydrocarbon Corporation (subsidiary of The Columbia Gas System, Inc.) is prepared to produce up to 350 million pounds of ethylene per year.

Adjoining the Columbia Hydrocarbon plant, and nearby, are three sites available for a manufacturer contemplating the use of ethylene or other products of this plant. All three sites are clear and almost level, and provide ready access to rail, highway and water transportation.

There is plenty of water, power and labor. And the area is centrally located with relation to major consumer markets.

Detailed information on these and other Ohio River plant sites will be furnished in complete confidence. Just write or call: Wayne C. Fletcher, Director of Industrial Development, Chesapeake and Ohio Railway, Huntington, West Virginia.

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State-by-state PLANT SITE check off list

Photo: courtesy W. R. Grace Co.

Each state in the union has certain advantages as a location for a plant site. It is difficult to give a comprehensive picture for each and every one. This check-off list of the 50 states plus Puerto Rico gives a capsule view of some of the critical aspects of plant site selection, such as taxes. These, while not process items, nevertheless can have a direct effect on whether a plant can operate economically and competitively. Pertinent facts have been assembled to give a quick run-down on all states and these are complemented by a concluding statement from each state.

ALABAMA

Industrial Tax Structure. Corporate Income Tax 3% of net income. Expenses, interest paid or accrued and taxes paid or accrued, bad debts and uninsured losses, are deductible. Franchise tax is $2.50 per $1000 of capital employed in state. Ad valorem assessment rate is 60% of market value. Average assessment rate of the counties is 20% of valuation on state-wide basis. There is a sales tax of 3%. On retail sales of automotive vehicles, truck trailers, semi-trailers, and machinery used in mining, quarrying, compounding, processing, and manufacturing, the Sales-Use Tax is 1½%. Exemptions: The State Legislature has authorized each gubernatorial administration to grant an ad valorem exemption on building and equipment for new and expanded industry for up to a ten year period.

Transportation. Total railroad mileage is 4669. Leading railroads: Alabama Central; Alabama Great Southern; Birmingham Southern; Mobile & Gulf; Gulf, Mobile & Ohio; Illinois Central. Major port is Mobile on the Gulf of Mexico. Others: Decatur, Florence, Sheffield, Huntsville, Guntersville, on the Tennessee River. Tuscaloosa and Birmingham, on the Warrior, and Columbia, on the Chattahoochie, are other leading cities with inland waterways.

Raw Materials. Large deposits of iron ore and coal. Others are limestone, dolomite, talc, kaolin, petroleum, natural gas, salt, mica, bauxite, pulpwood.

Water Supply. Water is one of the state's great natural assets. The supply is plentiful. An abundance of fresh water is suitable for hydro-electric power generating, transportation, and processing.

Power and Fuel. Typical billing in January, 1959, for

Birmingham: 300 kilowatt, 60,000 kwhr, $820. 1000 kilowatts, 200,000 kwhr, $2550; 400,000 kwhr, $3550. In Gadsen, Mobile and Montgomery it is slightly higher, with a figure of $4070 for 1000 kilowatts, 400,000 kwhr. Fuel rates are favorable.

State Speaks. Within the state are to be found the natural resources which constitute the basic raw materials for a variety of chemical processing and manufacturing operations. Since World War II, the chemical industry has been developing these resources and markets at an accelerated rate. Alabama now ranks eleventh in the nation in the construction of new chemical plants, and probably higher in diversity of products processed. There are now seven integrated chemical pulp mills operating in the state, producing a wide variety of end products. Improved forestry management practices, and wider application of them, will support a much larger chemical pulp industry in the future. Annual growth still exceeds amount cut by a safe margin. The salt deposits are now being tapped to produce chlorine and caustic soda. A sizeable insecticide industry has been established which can make full use of the chlorine available. New wells are being brought into production after the discovery of substantial oil deposits in recent years. With petroleum, natural gas and chlorine available, plants for production of chlorine-hydrocarbons have a good future. The "building blocks" for the organic chemical industry are in the state: Water, power, workers, and a favorable tax structure.

ALASKA

Industrial Tax Structure. Under Alaska's Net Income Tax Act, corporations are subject to 18% of the Federal income tax, payable on income from sources within the state. Oil and gas production subject to gross tax of 1%. Exempted business is free from income tax on its industrial development income for ten years after start of operations. Exempted business property used in activity giving rise to exemptions, and personal property devoted to industrial development is not subject to taxes for set periods. This is five years on more than $1 million investment; 6 years on more than $1 million but not $3 million; 7 years on over $3 million but not $5 million; 8 years on over $5 million but not $7 million; 9 years on over $7 million but not $10 million; and 10 years for over $10 million.

Transportation. The Alaska railroad, 5397 miles, is operated by the U.S. Department of Interior. Over twenty miles of the Yukon & White Pass Railway is in the state. Ports are: Ketchikan, Wrangell, Petersburg, Sitka, Juneau, Haines, Skagway, Yakutat, Cordova, Valdez, Seward, Kodiak, Anchorage (being improved), Dillingham, Bethel, Adak. Access to inside passage of Alexander Archipelago is provided by each southeastern city.

Raw Material. Coal reserves are estimated equal to Pennsylvania's original reserve. Also available are high calcium limestone, petroleum, raw sulfur, and pyrite. Also mercury, antimony, and ceramic clays.

Water Supply. Adequate supply of water is available. In some areas, there is a problem of quality because of glacial silt.

Power and Fuel. In Anchorage, rate is 4.5¢ per kwhr, first 60 kwhr per kw demand; 2.5 per kwhr for next 10,000 kwhr; 2.0¢ per kwhr next 20,000 kwhr; 1.7¢ per kwhr all additional kwhr. Fairbanks has large power service to customers with connected loads of not less than 25 hp for general power purposes. Lighting not exceeding 10% of the total energy consumed is permitted. Single phase 240 or 2400 volts; 3 phase 240, 480, 2400, or 4160; as available and at utility's option. Natural gas, 75¢ per cu. ft.; coal, 68¢; oil, $1.45; propane, $7.85; all per million Btu's. Coal is $10.85 to $15.12 per ton, depending on coal field and freight.

State Speaks. The new state offers tremendous reserves of raw materials, and practically virgin territory. The rapidly expanding Japanese market already imports 98% of its crude oil, and 21 million barrels of refined petroleum products annually. Last year alone, the 26 oil and gas companies spent over $30 million in exploration. An anticipated demand for sulfuric acid in large quantities, and four multi-million dollar wood pulp plants and a major news print plant, are excellent potential markets. With estimated coal reserves so great, coal from the 12 coal mines so far has been used for solid fuel purposes only. With advances forecast in low temperature carbonization methods, coal derivative products will have a good market in Japan. Alaska's Division of Tourism and Economic Development, and Division of Mines and Minerals is playing a leading role in helping industries to locate. #

ARIZONA

Industrial Tax Structure. State has corporate or organization and qualification fees (filing fees only with rates varying), a corporation annual filing fee at a flat rate of $25.00 annually, and a general income tax (withholding) at corporation rates of 1% on first $1000; 2%, 2½%, 3%, 3½%, and 4% on each subsequent $1000; and 5% over the sixth $1000. In addition, a general property tax can be assessed on full cash value of real property and tangible personal property. In practice, property is valued at a fraction of full value (avg. approx., 20% to 35%). Machinery and equipment assessed at 50% of book value. No inventory tax on raw materials, parts, or finished products. Unemployment insurance tax based on first $3000 of wages paid by employers at 0.5 to 2.7% rate (Arizona avg., 1.26%).

Transportation. Two leading railroads are Atchison, Topeka & Santa Fe (1557 miles) and the Southern Pacific (1665 miles). State has no ports. Local and regional air service offered by Trans-World, American, Western, Bonanza, Frontier, and Apache Airlines. Over 30 motor carriers serve the State.

Raw Materials. State is second in national production of asbestos, sixth in clays (bentonite), and eighth in gypsum. Mineral wealth has long accounted for substantial portion of state's economy.

Water Supply. Colorado River flows on north and west border of state. Several large dams (Coolidge, Roosevelt) control water. Many areas are arid.

Power and Fuel. Type of electrical service: single or three phase, 60 cycles, at standard voltage selected by customer. Monthly bill at following rate: 90¢ for use of 12 kwhr; 2.83¢ per kwhr for next 488 kwhr; 2.25¢ per kwhr for next 3000 kwhr; 0.9¢ per kwhr for next 42,000 kwhr. Monthly gas bill at following rate: 90¢ for 5 therms; 11.5¢ per therm for next 20 therms; 6.8¢ per therm for next 25 therms; 5.1¢ per therm for next 700 therms; 2.8¢ per additional therms.

State Speaks. During the last ten years, Arizona has experienced an industrial revolution resulting in a rapid increase in manufacturing and processing. Almost one thousand plants of all types are doing business in Arizona today, employing approximately 45,000 people with an annual payroll in excess of $221 million. Arizona is a business state and offers many attractions to industrialists. A favorable tax climate, ideal weather and working conditions, a right-to-work law, excellent transportation in the midst of the fastest growing market in the country have contributed to the solid industrial growth of this area. The desire for a continued economic growth by the citizens is reflected by the outstanding business climate. We feel that any suitable chemical industry would prosper in Arizona, the hub of the Southwest region. #

ARKANSAS

Industrial Tax Structure. General property tax, county rate, not in excess of 14 mills. Municipal rate is 17 mills. Legal assessment is 20% of market value. Corporate income tax is 5%. Accelerated depreciation of new business construction, as in Federal income tax law, is deductible. Corporate franchise tax, $1.10 per $1000 of outstanding capital stock employed in the state. Sales tax, 3% of gross receipts from retail sales. Use tax, 3% of sale price of tangible personal property. Severance tax on producer of natural resources, based on quantity or value of resource severed or removed for sale. Coal and lignite per ton, 2¢; barite, bauxite, titanium and manganese ores, 15¢ per ton; oil, market value at time and place of severance, 5%.

Transportation. Nearly 40 railroads run through the state. Included are: Chicago, Rock Island & Pacific; Kansas City Southern; Illinois Central; Texas & Pacific; Midland Valley. Barge transportation is on the Mississippi and Ouachita Rivers. Deepening of the Ouachita, and dam construction work to provide a nine-foot channel on the Arkansas River are underway.

Raw Material. Natural gas and petroleum, silica sand, lignite, coal. Nearly three-fifths of the state is forest. Bauxite produced is more than 90 percent of entire U. S. output. Other materials: clay, salt and sulfur.

Water Supply. Ample good quality water is available. The upper Ouachita River basin is eminently suited to industrial needs. Streams in the White and St. Francis Rivers are low in dissolved solids. In southern and eastern regions, shallow wells can supply over 500 gallons of fresh water per minute.

Power and Fuel. Typical electric billings in January, 1959, in Little Rock: 300 kilowatts, 60,000 kwhr, $1047; 1000 kilowatts, 200,000 kwhr, $3079. In Fort Smith, 300 kilowatts, 60,000 kwhr, $1158; 1000 kilowatts, 200,000 kwhr, $2901. Fuel is relatively low in cost.

State Speaks. The Arkansas Industrial Development Commission encourages and assists firms to establish themselves in the state. There are many excellent plant sites available, particularly for industries with large water requirements. An ample supply of labor possessing the necessary qualifications is available. In a recent survey of employee attitudes, the attitude score of Arkansas production workers was 22 percentiles above the level of production workers in other parts of the country. (This survey used the SRA Inventory developed by the University of Chicago.) The Arkansas climate is temperate, with long and moderate summers, and short and relatively mild winters. Many resources in the state are naturals for chemical processing industries. Especially recommended as advantageous for plants to produce in Arkansas are nitric acid, ammonia, acetylene, methanol, formaldehyde, chlorinated hydrocarbons, polyolefins, sodium silicates, ceramic products, rocket fuels. For technical personnel, Arkansas has an excellent school of engineering in Fayetteville, and a Graduate Institute of Technology in Little Rock. #

CALIFORNIA

Industrial Tax Structure. Property tax of 7% on a statewide average basis on assessed valuation which is generally about one fourth of actual value. Corporate tax of 5.5% of net earnings on business done in state. This can be partially offset by federal income tax and by fast write-off of depreciation.

Transportation. California is served by four major transcontinental railroad companies as well as a number of short lines which operate on more than 7500 miles of track. Rapid freight or passenger service is provided to all parts of U. S., Mexico, and Canada. Major ports are: San Francisco, Oakland, San Pedro (Port of Los Angeles), San Diego, Stockton, Long Beach, and Eureka.

Raw Materials. Second among states in mineral production. Petroleum, natural gas, and allied products account for 77% of mineral products value. Has largest known reserves of boron minerals. Other materials are rare earths, cement, sand and gravel, stone, clays, gold, and lime.

Water Supply. Water resources distributed unequally throughout state. Precipitation varies from 110 in. per year in northwest to less than 2 in. per year in southeast. Water storage dams have been developed. Water hardness is 79 ppm. Costs 13¢ per 1000 gal. in quantities of 1 million gal. per month. Some localities have problems with respect to air and stream pollutions where certain industries may find it advisable to avoid.

Power and Fuel. Typical average monthly electric costs for 1000 kw demand are 1.47¢/kwhr for usage of 200,000 kwhr, 1.13¢/kwhr for 400,000 kwhr. For 300 kw demand, the average cost per kwhr is 1.65¢ for 60,000 kwhr monthly consumption, 1.25¢/kwhr for 120,000 kwhr usage. Cost of industrial gas is 4.97¢/therm for 5000 therms monthly delivery, 3.85¢/therm for 500,000 therms monthly delivery (1 therm = 100,000 Btu).

State Speaks. California is favored by both variety and abundance of resources. The state leads all others in agriculture and fisheries, and is second in timber reserves and in minerals. In regard to minerals, it is deficient in coal and iron, but possesses an almost unrivaled variety of others in commercial quantities. Furthermore, many minerals are also in large supply in adjoining states. The growing population and the high per capita income in California insures continuation of the increasing demand here for all sorts of products. Along with this has gone an almost unprecedented growth and diversification of industry. Thus, California has established the basis for a great industrial complex offering advantages for every type of industry. It has resources, excellent labor force, ideal climate, training facilities, ready markets near at hand, and advantageous location for shipping to markets outside the state. The chemical industry has only recently been taking advantage of these and consequently has room for unlimited expansion in the future. #

COLORADO

Industrial Tax Structure. Corporate income tax at 5% of net income, federal tax not deductible. Organization and qualification fees based on value of capital stock: ranges from $25 for less than $50,000 up to $165 for up to $1 million; an additional 10% of above tax is added for old age pension fund; $5 for reserving corporate name; $25 for articles of amendment, merger, consolidation, etc. For foreign corporations, in addition to franchise tax, certificate of authority to transact business is $60; amended certificate of authority is $25; articles of merger, $25; certificate of withdrawal, $5; change of designated official or agent, $5. Corporation franchise tax rate based on amount of capital stock—$10 for first $50,000 up to $250 on $1 million or more. State property tax is 2.403 mills ad valorem, plus local taxes. Unemployment insurance tax rate varies from 0 to 2.7% on first $3,000 of individuals' earnings.

Transportation. Six major railroads have over 3,500 miles of track in Colorado. Denver & Rio Grande Western leads with 1,368 miles, Union Pacific and Atcheson, Topeka & Santa Fe each have slightly more than 600, while the remainder is divided between Colorado & Southern, Chicago, Burlington & Quincy, and Rock Island.

Raw Materials. State is ranked first in U.S. as molybdenum source, and second and third for fluorspar and feldspar, respectively. Also has ten other metal ores plus oil shale, gilsonite, coal, petroleum, and beet sugar.

Water Supply. Water is generally available but may pose problems for extremely large users east of continental divide.

Power and Fuel. Metropolitan Denver is used as representative area (comprising four counties). Industrial rate is about 8 mills per kwhr with 5,000 kw demand and 70% load factor. Lowest rate step for interruptible industrial fuel gas charge runs about 17.3¢ per 1,000 cu. ft., plus 2.1¢ per therm (10^5 Btu). Gas rated 825 Btu per cu. ft. because of altitude (equivalent to 1,000 Btu at STP).

State Speaks. There are many reasons why chemical industries would want to locate in Colorado. The state has tremendous reserves of coal and is situated within the region containing the world's largest deposits of oil shale. Other chemicals or chemical raw materials found or manufactured in Colorado include sulfuric acid, aluminum sulfate, fertilizers, organic and inorganic specialty chemicals, explosives, coal chemicals, beet sugar, insecticides, rubber, portland cement, ceramics and refractories, gilsonite, petroleum and natural gas. Mineral reserves with prominent future potential include copper, zinc, titanium, rare earths, fluorspar, molybdenum, and oil shale. In addition to this abundance of raw materials, there is a rapid population growth, an ample trained labor pool, an ideal place to live providing ease of attracting and holding professional people, availability of suitable plant sites and reasonable construction costs, availability of abundant power and fuel, and a favorable business climate. #

CONNECTICUT

Industrial Tax Structure. Domestic corporations pay fee at following rates: $1 per $1000 of authorized capital for corporations with par value stock, $1 for each 100 shares or $1 per $1000 if stock exceeds $10 for corporations without par value stock. Foreign corporations pay annual filing fee of $100 for registration, and $16 to file an annual report. State has a corporation business tax based on entire net income and assessed at 3¾%. Unincorporated businesses pay $1 per $1000 up to $60,000, $2 per $1000 over $60,000. Each company is taxed locally under the ad valorem tax on property, real or personal, including machinery and inventory. Rates vary throughout state.

Transportation. Major rail carrier is the New York, New Haven and Hartford Railroad (760 miles). Three plans available for shipping freight in trailers on flat cars. The three principal harbors on Long Island Sound are New London, New Haven, and Bridgeport. Several river ports, such as the city of Norwich, are of interest to industry. Bradley Field, in central Conn., is the 14th leading airport in terms of cargo originating there. Approx. 750 trucking firms handle interstate service.

Raw Materials. State is not considered a producer of raw materials, but, due to its excellent transportation facilities, raw materials for the chemical industry are readily procured.

Water Supply. Water is readily available in the state as surface water (8400 miles of rivers and streams and 4093 lakes covering 48,510 acres). A supply of ground water of good quality is available, but undeveloped.

Power and Fuel. State has 12 private and public utility companies serving the area. Rates vary throughout state. Typical industrial bills for 1000 kw demand are $3176 for 200,000 kwhr and $5266 for 400,000 kwhr at New Haven and Bridgeport. State is supplied with industrial gas, LPG, coal, and fuel oil. Rates vary.

State Speaks. Many factors must be considered in selecting a site for a plant. The state selected might not have all of the advantages desired, but the particular points registered may carry more weight by insuring profitable operations or by enabling the company to render the best possible service to its markets. From Connecticut the nation's wealthy markets are easily accessible. Within a 500-mile radius one finds a consumer market with the following percentages of U.S. totals: 37% of effective buying income, 35% of retail sales, 33% of population; also, an industrial market of 44% of manufacturing firms and 41% of value added by manufacture. The above figures, coupled with the state's excellent transportation facilities, make Connecticut a most desirable place for locating chemical plants. The proper elements leading to effective production, distribution, and consumption are found in this area. #

DELAWARE

Industrial Tax Structure. There is a 5% net corporate tax on profits derived from operations in the state. In Newark and Delaware City, a ten year exemption from local taxes is granted. There is no state or county exemption. On local real estate, county tax is 47¢ per $100 of assessed valuation on land and buildings only; assessment 70% of value. Other taxes: school taxes, from 30¢ per $100 to $1.00 per hundred, using county assessment, and depending on location of district.

Transportation. Delaware has several leading railroads. The largest are the Pennsylvania—304.11 miles; Baltimore & Ohio—35.5; and The Reading Co.—21. The Delaware River and Delaware Bay border the entire state. Major ports providing access to oceangoing vessels are Wilmington, Lewes and Delaware City. They also connect with inland waterways.

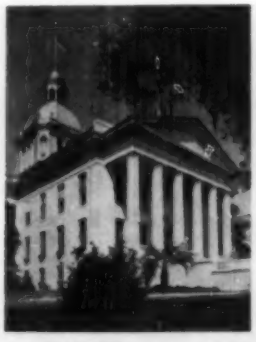
Raw Materials. While no major raw materials are actually found in the state, they are easily and economically accessible for practical plant location. Examples: the Delaware Refinery of Tidewater Oil Co. at Delaware City, and titanium dioxide plants of Du Pont at Edgemoor and Newport.

Water Supply. The supply of both ground and surface water for industrial purposes is more than adequate. In the lower part of the state there is untapped ground water in large quantities. These untapped reserves are available for chemical processing.

Power and Fuel. Power rates vary slightly from city to city. Typical electric power billing for the city of Wilmington on January 1, 1959, was: for 300 kilowatt demand, 120,000 kwhr consumption, $1614. For 1000 kilowatt demand, 400,000 kwhr consumption, $4913. Newark, another leading city, on 300 kilowatt demand has billing of $2337 for 120,000 kwhr consumption. On 1000 kw demand, 400,000 kwhr consumption, billing is $7480. Dover is slightly higher than this. It runs $2365 for 120,000 kwhr and $7643 for 400,000 kwhr.

State Speaks. Delaware is known as the chemical capital of the world. This name has been applied not only because of research and educational facilities in chemicals, but also in their production. Three large chemical concerns have research headquarters in the state. Not the least of Delaware's assets is its location. In the center of a heavy consumption area, with water, rail, truck, and air transportation facilities, it has a decided edge on some other eastern states for location of chemical plants. Raw materials for conversion into chemicals, petrochemicals and petroleum derivatives are easily brought in by means of the famed Delaware River Basin, and the excellent port facilities at the three leading cities of Wilmington, Delaware City and Lewes. Such bulk items as fluorspar and illium ore offer testimony as to the economical ease of supplying chemical plants in the state with raw materials.

FLORIDA



Industrial Tax Structure. There is no state or local income tax on individuals or corporations, also no state ad valorem tax on real or tangible property. State levies a corporation charter tax (graduated rate depending on number and type of stock), a corporation capital stock tax (franchise tax) with minimum fee of $10 and maximum of $1000 annually, and occupational license fees for all business occupations and professions (rate and base varies). Counties and municipalities account for the bulk of property taxes levied. County ad valorem taxes are based on assessment of property and vary throughout the state.

Power and Fuel. Typical monthly electric bills for 75 kw demand are $443 for 15,000 kwhr, $641 for 30,000 kwhr. For 1000 kw demand, the cost is $4486 for 200,000 kwhr, and $6322 for 400,000 kwhr. Bills vary throughout the state. Natural gas is now available throughout the state since completion of a pipeline from Texas and Oklahoma.

Transportation. There are 14 customs ports of entry and 13 deep-water ports providing a minimum channel depth of 25 feet or more in Florida. The state has a large and growing system of inland waterways (1000 mi. of navigable channel) for barge transport. Over 14,000 miles of state maintained roads are suited to economical highway transportation, some 300 intrastate and 100 interstate freight lines being registered. Thirteen railroads serve Florida with a network of more than 4700 miles of track. There are 21 airports served by 33 scheduled air carriers.

Raw Materials. State produces nearly three-fourths of the phosphate rock in the nation. Other minerals are: limestone, sand, gravel, fuller's earth, titanium and zirconium concentrates. State also has vast forest reserves (nearly 22 million acres).

Water Supply. Water is abundant. Surface water accounts for less than 20% of water used, about 80% depend on abundant supply of ground water. State has 14 first magnitude natural springs, also many wells.

State Speaks. Florida's industrial growth in the last decade has been spectacular. In mid-1959, the industrial employment increased 101% over that of ten years earlier. This compares with a national gain of 10%. Value added by manufacture rose from $350 million in 1947 to $1130 million in 1956, an increase of 223% compared with a national gain of 88%. No one industry has dominated this growth. The synthetic fiber industry has paced expansion in the chemical industry with location of the Chemstrand nylon plant of American Viscose and Monsanto Chemical Companies in Florida. During the 1960s, Florida is destined to become a major industrial state. The industrialist who is considering Florida as a site for a new plant should look at the growth of the markets and industry in the state.

GEORGIA

Industrial Tax Structure. Corporate net income is taxed at 4%. Multi-state income apportioned in accordance with average of these ratios: average finished goods inventory in Georgia to the same average everywhere; wages paid in Georgia to those paid everywhere; and gross receipts from business done in Georgia to gross receipts everywhere. Franchise tax based on net worth, on a graduated scale. For foreign corporations, base is proportion of issued capital stock and surplus employed in Georgia. General Sales-use tax of 3%; Exemptions: Industrial materials which become component parts of finished product, or "coated or impregnated into the product at any stage of its processing, manufacture or conversion"; property imported into the state, which was acquired before 1951, and property upon which sales tax of 3 or more percent was paid in another state which reciprocates. Limited ad valorem tax. City and county property rates based on local digest. Assessed values vary from 10% of market value to 60%. Average is about 20%.

Transportation. Leading railroads are: Central of Georgia—1,218 miles; Atlantic Coast Line—1,124; Southern Railroad—960; Seaboard Air Line—939; Georgia Railroad—321; Louisville and Nashville—289; Georgia & Florida—250; Georgia Southern and Florida —240. Leading ports are Savannah and New Brunswick on the Atlantic. Leading cities located on the Savannah River are Bainbridge and Augusta. Columbus will shortly have an eight-foot channel to the Gulf, and Bainbridge now provides barge transportation to the Gulf.

Raw Material. Georgia ranks first in the nation in kaolin and ochre, third in bauxite and barite. Other important materials are: naval stores, limestone, cellulose, titanium, chlorine, caustic, ammonia, sulfuric acid, resins.

Water Supply. The supply of industrial water is plentiful, quality is excellent. Only in the mountainous areas of North Georgia is there a problem of supply.

Power and Fuel. Georgia's electric power rates are among the lowest in the country. Slight variations are based on demand, power and load factors. Typical electric bills, January, 1959, in Atlanta are: 500 kilowatts, 100,000 kwhr, $1537. For 1000 kilowatts, 400,000 kwhr, $4075. Augusta, Columbus, Macon, Savannah are approximately the same. Fuel average is about 25.67¢ per million Btu for large industrial users throughout the state. Coal is at 30-40¢ per million Btu, and oil at 53.3¢ per million Btu.

State Speaks. Georgia ranked fifth as a preferred site for new chemical plants in a recent survey of chemical firms. Its position as the Southeast's most important distribution center, and central location in the expanding southeastern market, are also factors. Specific markets for chemical producers considering Georgia for location are: textile and synthetic fiber industry, pulp and kraft paper industries, glass, ceramic and cement industries. The area is an important consumer of fertilizers and pesticides. Other potentials are production of petrochemical raw materials from natural gas (presently under study). Excellent supply of labor, including large anticipated number of chemical engineering graduates from Georgia Tech in Atlanta. Atlanta is the center of a network of highways, railroads and airlines. Ports are suited for commerce with Europe and South America.

The Atlanta area was also ranked as fifth most preferrable site by the above mentioned survey among nations, cities and metropolitan areas. There is great possibility for new chemical industry of many kinds.

HAWAII

Industrial Tax Structure. Manufacturers assessed a general excise (also called "gross income") tax at 1% of gross revenues to end of 1960; rate will be one-half of 1% as of January 1, 1961. A 3½% retailing tax on finished product. Property tax based on 70% of fair market value. Corporation net income taxed 2¾% on capital gains; 5% on all other taxable income under $25,000; 5½% all over $25,000. For healthier tax climate to encourage expansion of existing industries, and attract new industries, newly-legislated decrease in general excise tax on manufacturing from 1% to one-half of 1% of gross revenues, effective January 1, 1961.

Transportation. No railroads on the islands, but the state is served by eleven airlines plus air taxi, and by steamers from the mainland. Ports are available to ocean-going vessels at Honolulu Harbor (Oahu), Hilo and Kawaihae Harbors (Hawaii), Kahului Harbor (Maui), and Nawiliwili Harbor and Port Allen (Kauai). No inland waterways or water transport facilities.

Raw Materials. None of the usual major chemical raw materials known to exist, although some minerals such as bauxite and titanium are evident. Agricultural by-products are an important industrial potential. Crude oil from Arabia and Sumatra will be processed in the new Standard Oil of California refinery in the Campbell Industrial Park on Oahu.

Water Supply. Adequate water suitable for industrial use is available on the major islands. Stream waste disposal laws are neither unusual nor stringent.

Power and Fuel. Chemical industry rates for electric power: energy charge—first 50 kw per month, $1.26 per

kwhr; next 100 kw per month, 94¢ per kwhr; next 250 kw per month, 79¢ per kwhr; next 400 kw per month, 74¢ per kwhr—demand charge (excess over established norm)—first 150 kw, $345 flat fee; next 350 kw, $1.85 per kw; next 1,000 kw, $1.35 per kw; over 1,500 kw, $1.10 per kw. Primary service discounts and power factor adjustments. Prevailing rate on fuel cost is 1.035 mills per kw. Within Honolulu city limits manufactured gas is rated 860 Btu with 0.89 sp. gr., under 8-in. water column pressure for commercial establishments. In rural areas and on Neighbor Islands, low pressure gas rated 3,273 Btu with 2.0 sp. gr.

State Speaks. The usual raw materials processed by the chemical industry are lacking in Hawaii because of the islands' geological "youth." However, the advent of the Standard Oil refinery offers definite chemical by-product potential—some 26 products are planned. Agricultural by-products (from sugar, pineapples, etc.) are being extensively researched. Hawaii's natural resources are mild, temperate climate and harmonious peoples; combination considered high on list of inducements to attract qualified technical personnel and top executives to a new location. Ample labor force of dependable, productive workers. University of Hawaii offers Masters and Doctorate in chemistry. Chemistry and laboratory technicians graduating from Hawaii U. fully qualified for all phases of chemical production.

IDAHO

Industrial Tax Structure. Corporations and individuals must pay a state income tax. Credit is allowed for federal income tax; corporation rate is 9.5% on all taxable income (however, because of reciprocal allowances, net tax on corporations usually averages less than 3% of net income). For corporations having income sources both within and without the state, the three-factor method of computing is used, based on property, payroll, and sales. Initial filing fee for corporations ranges from $20 for under $25,000 authorized capital stock to $200 for over $1 million; in addition to filing fees, at time of filing articles of incorporation all corporations (except tax exempts) required to pay annual corporation license tax: range is from $20 for $5000 capital stock to $300 for over $2 million. Local taxes vary but average close to 16% for assessment ratio on real property. All corporations required to pay unemployment compensation tax of 1.5% on first $3,000 individual earned income.

Transportation. Nine railroads with more than 3,200 miles of track in Idaho include: Union Pacific; Northern Pacific; Chicago, Milwaukee, St. Paul & Pacific; and Great Northern; plus five other lesser local lines. Current road construction and existing main highways favor growing trucking and combined rail-trailer service. Three major airlines—United, West Coast, and Western—connect with rest of nation, while taxi airlines have access to 196 airports throughout state.

Raw Materials. Over forty mineral commodities included in the state's resources. Major production has been lead, silver, zinc, gold, copper, antimony, cobalt, rare earths, mercury, silica, limestone, phosphate rock, aluminum clays, cement, pumice and cinder (and, potentially, beryllium and cesium) in addition to large timber preserves for paper manufacture.

Water Supply. Idaho is one of three states in continental U. S. with no water shortage. Ground and surface water is more than adequate, and almost all is classified as excellent.

Power and Fuel. Rates quoted as 15 to 25% less than national average; from $180 per 15,000 kwhr for 75 kw demand to $4,030 for 400,000 kwhr at 1,000 kw demand. Unlimited electric power available due to greatest hydro-electric potential in the country. Almost unlimited natural gas supply accessible from nearby surrounding sources.

State Speaks. Attractions for chemical industry in Idaho include the wide gamut of minerals and chemical raw material sources, huge quantities of high quality water, a new supply of natural gas, reasonably-priced power, stable labor force, a large, growing market for agricultural chemicals within the state and in neighboring states, and an abundance of available plant sites. Recent breakthrough in coking of sub-bituminous coals of the area presages growth of this industry, and is coupled with the growth of the phosphate industry (which had a recent annual production of 2,000,000 long tons) due to savings in fuel transportation costs. #

ILLINOIS

Industrial Tax Structure. Illinois levies no corporate or individual income taxes, nor a tax on property for state purposes. Franchise tax at 1/20 of 1% based on domestic and foreign stated capital and paid-in surplus representing property and business in Illinois. Organization and entrance fees at 1/20 of 1%: for domestic corporations—based on value of entire consideration received for issued shares, or increases, stated capital or paid-in surplus; for foreign corporations—proportion of stated or increased capital and paid-in surplus represented in the state. General sales and use tax at 3%. Sales tax based on gross receipt from sales of tangible personal property. Use tax imposed on repairing and privilege of using in the state tangible personal property purchased anywhere at retail. Property taxes in Illinois are function of local governments.

Transportation. Illinois is served by a large network of railroad lines, including the Atchison, Topeka & Santa Fe; Chicago, Milwaukee, St. Paul & Pacific; New York Central; Pennsylvania; Illinois Central; Baltimore & Ohio; Chesapeake & Ohio; Erie. Chicago is main port for ocean-going vessels, as well as for access to inland waterways.

Raw Materials. Petroleum, coal, natural gas, limestone, fluorspar, lead, zinc, gypsum, feldspar. Location on inland waterway and Great Lakes-St. Lawrence Seaway assures adequate supply of all raw materials.

Water Supply. Generally adequate in all parts of state.

Power and Fuel. Typical urban industrial power rates (Chicago) are: demand charge from $2.00 per kw per month for first 200 kw of demand, graduated down to $1.10 for all over 15,000 kw demand. Energy charge from 2.33¢ per kwhr for first 6000 kwhr per month graduated down to 6.5 mills per kwhr for all over 500,000 kwhr per month. Typical industrial gas rate is: 8.5¢ per therm (10^5 Btu) for first 800 therms per month, graduated down to 5.5¢ per therm for all over 20,000 therms per month.

State Speaks. Outstanding reasons why chemical industries should locate in Illinois, particularly in Metropolitan Chicago, are markets and transportation. Chicago is the second largest metropolitan area in the country, and is listed in *Dun's Review* as the nation's leading industrial market. From January 1, 1955, to July 1, 1960, over $145 million was spent on new construction in the chemical and allied products industries in Metropolitan Chicago. This city is served by nineteen trunk line railroads, operating nearly one-half of the nation's total railroad mileage. Its location at the junction of the Great Lakes-St. Lawrence Seaway system, and the Illinois-Mississippi Inland Waterway, affords both deep-draft and barge transportation. #

INDIANA

Industrial Tax Structure. Property tax: state 1/3 mill; city-county-township median $2.42; (unincorporated area, county-township, median 1.08 mill). Gross income: state, ½ of 1% on gross receipts from sales not in interstate commerce, with 100% exemption on interstate sales. Intangibles: 5¢ per $20 market value of intangibles held. Tax advantages to induce industry: a) standardization of assessment procedures on local level to favor industry (effective 1961); b) gross income tax designed to encourage location of industries whose sales are primarily interstate. Unemployment compensation on experience basis.

Transportation. Twenty-six railroads have about 6700 miles of track in Indiana. Principal lines include: Baltimore & Ohio; Chesapeake & Ohio; Chicago & Eastern Illinois; Erie; Illinois Central; New York Central; Pennsylvania; Louisville & National; and Southern & Wabash. Facilities for ocean vessels are Indiana, Calumet, Buffington, Michigan City, and Burns Harbors, all on Lake Michigan. Evansville, Mt. Vernon, Jeffersonville, Madison, and Aurora front on the Ohio River.

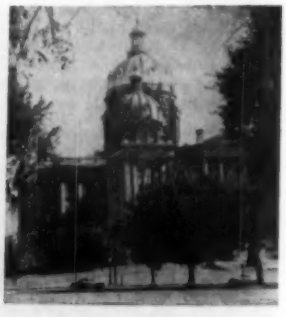
Raw Materials. Indiana ranks among the top states in production of coal, refinery gases, and high calcium limestone. In addition, there are clay, gypsum, silica, and natural gas available.

Water Supply. Unlimited water is available in urban centers. Both surface and ground water available in quantity in northern part of state and along rivers in southern Indiana. But inland water supplies are spotty. No unusual stream or air pollution laws. State is a member of Orsanco Compact controlling pollution of Ohio River and tributaries.

Fuel and Power. Typical electric power rates vary from 0.8 to 1.3¢ per kwhr depending on volume and power factors. Fuel rate for oil is 36.8¢ per million Btu, and for coal is 17.1¢ per million Btu.

State Speaks. Accessibility to both markets and raw materials, sound economic climate of the state, available labor supply, and technological products of first-rate engineering colleges, all point to desirable potentials for chemical plant location. The state is situated centrally to the large manufacturing centers of the midwest, and of the nation. Their markets are easily accessible; and with readily available and adjacent sources of rock salt, gypsum, magnesium salts, phosphate rock, pyrites, fluorspar, sulfur, petroleum, coal, petro-gases, limestone, clay, farm by-products, and abundant water supply, chemical process companies should find Indiana suitable to their needs. In addition, there are a number of complementary industrial products that could properly be located near the industrial Calumet area, or between it and the Ohio River, such as cyclic organic chemicals and derivatives, acetylene, plastics, vinyls, resins, hydrofluoric acid and its related products, and petrochemicals. #

IOWA



Industrial Tax Structure. State taxes include a real property tax on land, buildings, and permanent equipment assessed at 60% of actual value, a personal property tax on all tangible property not assessed as real estate (60% of actual value), and an intangible property tax. All assessments on industrial property are made locally. Net average millage rates in effect in 1959 are 84.726 in cities and towns, 52.761 in rural districts. State average is 66.605. The rate for the corporate income tax is 3% upon net income derived from business transacted within state. Other levies are unemployment compensation, sales tax, use tax, and organization fees.

Raw Materials. Major minerals are coal, gypsum, clay, sand, gravel, limestone, slate, lead, zinc, iron, peat, ochre, and sandstone. Agricultural raw materials: Corn and oats (ranked 1st), soybeans (2nd), furfural, starch, and animal by-products (ranked 1st).

Transportation. There are 8328.7 miles of Class I trackage, 346.61 miles of Class II trackage, in Iowa. Major railroads are: Santa Fe; Burlington; Great Western; Illinois Central; M. & St. L.; Union Pacific; Wabash; Milwaukee; Northwestern; Rock Island; and Great Northern. Sioux City and Council Bluffs on the Missouri and Clinton, Davenport, Dubuque, etc., on the Mississippi, provide access to ocean ports.

Water Supply. Industrial development has not been deterred by a shortage of water. In general, an adequate supply can be obtained in most areas for the average industrial plant. Operations requiring large quantities of water can also find suitable locations.

Power and Fuel. Electrical and fuel rates vary throughout state. Typical average industrial electric bills for 500 kw demand are $1897 for 100,000 kwhr and $2942 for 200,000 kwhr.

State Speaks. The rapid growth of the chemical industry in Iowa is proof that Iowa is a profitable location for many types of chemical plants. The chemical industry is Iowa's third largest, with a value of $118.8 million added by manufacture in 1958, a 154% increase over 1954. There were 168 chemical establishments employing 6013 persons in 1958. Coupled with its central location, Iowa's excellent transportation facilities enable it to draw upon the nation's raw materials, and in turn distribute the products of its chemical plants over a large area. Overnight delivery allows small inventories, while alternate sources protect price and availability. Natural gas is available in most areas of the state, and an LP pipeline is to be constructed in the near future. Favorable wage rates, highly productive workers, and an adequate labor supply, add to the attractiveness of Iowa for chemical plants. Two state universities train chemical engineers and provide graduate study and research projects. #

KANSAS

Industrial Tax Structure. Corporations, both foreign and domestic, are subject to a 3½% tax on net income from property located, and business transacted, in the state. Credit is allowed for federal taxes in computing net income. Manufacturers are subject to a 2½% sales or use tax on machinery or equipment purchased. Estimated rates based on actual sales value range from 8.77 mills to 17.35 mills with average of 12.78 mills for all taxing units. Uniform ½% on actual value, or 3% on income derived therefrom at the taxpayer's option. Annual capitalization fee of 1/10% for first $100,000 and 1/20% for excess based on proportion of total capital devoted to business in the state.

Transportation. Total railroad mileage in the state is 8,732. Leading railroads are Atchison, Topeka, and Santa Fe; Missouri Pacific; Chicago, Rock Island and Pacific; Union Pacific; Missouri, Kansas and Texas; St. Louis and San Francisco; Kansas City Southern; Chicago, Burlington & Quincy; and eight smaller lines. Water transportation is provided by the Missouri River barge service serving Atchison, Leavenworth, and Kansas City.

Raw Material. In top ten mineral producing states, Kansas ranks fifth in the nation in petroleum and natural gas, and seventh in salt production. Other raw materials available are: coal, zinc, lead, clay, gypsum, volcanic ash, carbon black, diatomaceous marl, glass sand, helium.

Water Supply. Available in quantity from both surface and ground sources. Surface water is chief source in eastern half of state, while ground water is in the western part. In the west, wells can supply at rate of 500 gallons a minute from a depth of 40 feet. Some cities have impounded well supplies with reserves sufficient for large industry.

Power and Fuel. Prevailing industrial power rates from 7 to 12 mills per kwhr. Natural gas: $0.18 to 0.30; coal: $0.20 to 0.40; oil: $0.28 to 0.40 per million Btu.

State Speaks. Kansas has many choice chemical plant locations with all the essential features. Area markets are growing, and other markets can be served from the geographic center of the contiguous states. The state of Kansas ranks high in the nation in petroleum and natural gas production, in basic minerals, and in transportation facilities. Fifth in petroleum and natural gas, the state has 32,000 miles of pipeline to transport these materials within the state and assure adequate and economical fuel and raw materials. The state ranks ninth in total value of mineral production and produces 31 basic minerals for industry. Kansas ranks fifth in railway mileage with more than 8500 miles of track, and six major transcontinental lines to provide good connections to all parts of the country. Crossed by more transcontinental highways than any other state, Kansas is second in state highway mileage, and is served by many major truck lines. Available to all industry is a pool of productive, easily trainable personnel from the rural areas of the state. From the universities and colleges come an excess of engineers and technical people. More than half the engineers and technical graduates of Kansas work in other areas.

KENTUCKY

Industrial Tax Structure. Domestic corporations pay an organization tax based on number of shares authorized (1¢ per share for first 20,000 shares with par value, ½¢ per share to 200,000). An annual license tax of 70¢ on each $1,000 value of capital stock represented by property owned or business transacted in state is levied against all corporations classified to do business in Kentucky. Corporation income tax of 5% on first $25,000 and 7% on over $25,000 of taxable net income after deduction of Federal income tax attributed to Kentucky operations. General property tax on machinery and equipment is 50¢ per $100 valuation (assessment at 33% current market value). Property taxes on real estate (assessed at approx. 31% of market value) at 5¢ per each $100 valuation by state. Local rates vary.

Transportation. Twenty-three railroads operate over 3802 miles of main track. Major carriers are Louisville & Nashville, Chesapeake & Ohio, Illinois Central, and Southern. Over 1,400 miles of navigable waterways are open to barge operations. Major ports are Ashland, Louisville and Paducah on the Ohio River, and Calvert City on the Tennessee River. Over 225 truck lines operate in state. Commercial airlines operate from 7 major airports.

Raw Materials. State ranks 3rd in coal, 4th in fluorspar, 12th in natural gas, 15th in petroleum. Limestone, clay and sand also among principal minerals.

Water Supply. Most of state has sufficient water for industry. Water is a problem in the eastern counties of Kentucky.

Power and Fuel. A general indication of the electric power rates is shown by the charge of approx. 1¢ per kwhr for 600,000 kwhr per month on a 1,000 kw max. demand basis for uninterruptible primary service. Rates are lower for higher rate factors. Coal prices vary between $5.10 to $6.50 per ton depending on grade and quantity. Large industrial customers (min. 500,000 cu. ft./day) buy gas at rates which step down to 37¢ per 1000 cu. ft.

State Speaks. General advantages of the chemical industry in Kentucky can be summarized as follows: (1) the state has an excellent geological location with a population of approximately 65,000 within 300 miles and overnight delivery of its borders, (2) good transportation facilities and all types of transportation including water, (3) bountiful supplies of water suitable for the chemical industry in most areas of the state including large supplies of underground water along the Ohio River, (4) the location within the state of a considerable number of chemical plants manufacturing a large number of products which can be used in other chemical processes, (5) the existence of a considerable number of raw materials which is used by the chemical industry, and (6) a large labor supply which, based on large installations in rural areas, have demonstrated the ability to learn chemical processing in a relatively short time.

LOUISIANA

Industrial Tax Structure. Corporations are subject to 4% of taxable net income. Franchise tax of $1.50 for each $1000. Ad valorem tax of 5.75 mills on assessed value. The rate of 1/20 of 1% on the par value of shares having such value; and ½¢ for each share without, up to 10,000 shares. Exemptions: ten-year program which permits the owners of a new or expanding facility to be exempted from state, parish and local ad valorem taxes for five years, with an option to renew for an additional five years. Subject to certain limitations, corporations may claim credit against income tax due to Louisiana for income taxes paid in other states.

Transportation. Eighteen major railroads serve the state. Included are: Chicago, Rock Island and Pacific; Kansas City Southern; Gulf, Colorado and Santa Fe. In New Orleans, the Public Belt Railroad, the nation's only community operated terminal switching line, has 140 miles of track adjacent to the waterfront. The Gulf Intracoastal Canal is one of the world's most important. Four major ports: New Orleans, Baton Rouge, Lake Charles, and Morgan City, open into the Gulf of Mexico. The Mississippi runs through the state.

Raw Materials. Louisiana ranks third in the nation in total value of mineral production, second in oil, natural gas and sulfur, and third in salt. Other materials are: tall oil, sand, soda ash, alumina, fluorspar, bauxite.

Water Supply. An almost inexhaustible supply of water is provided by more than 500 miles of waterways. Particularly noteworthy is the 100-mile strip on both banks of the Mississippi between Baton Rouge and New Orleans.

Power. Typical electric bill, January 1959: 300 kilowatts, 60,000 kwhr, $1192. 100 kilowatts, 200,000 kwhr, $3477, in Baton Rouge.

State Speaks. With over 70 major companies located in Louisiana, the petrochemical firms are living up to the axiom that the industry is its own best customer. The abundance of oil, gas, sulfur, salt and processable water is vital. Louisiana is now deep in a great cycle of petrochemical complexes, manufacturing basic and intermediary products. The next ten years should see the advent of the final cycle: integrated consumer production industries. Key is the Mississippi River, and the vast inland waterways system which link Louisiana with 19 states in the American industrial heartland. Of the Baton Rouge-New Orleans area, the editor of the *Journal of Commerce* has said, "Perhaps nowhere in the U. S. can there be found finer industrial on-water sites than the 100-mile strip on both banks of the Mississippi. #

MAINE

Industrial Tax Structure. There is no state corporate income tax or corporate excise tax. All real estate taxes are levied at the community level. Corporate franchise tax: Corporations are subject to an annual tax based on par value of capital stock or number of authorized shares—from a minimum of $10.00 for authorized capital not in excess of $50,000. to $100 for the first $1 million, plus $50 for each additional $1 million. Compilation of tax laws for business taxes is available from State Bureau of Taxation.

Transportation. Total railroad mileage is 1797. Leading railroads are Maine Central—779 miles, and Bangor & Aroostock—596. Other rail companies are Canadian Pacific—177; Canadian National—90; Boston & Maine—43; Portland Terminal Co.—40; and Sanford & Eastern—32. Of eleven ports, major ones are Portland and Searsport. Northeast Airlines operates regular cargo service from Portland, Lewiston-Auburn, Augusta, Rockland, Waterville, Bangor, Houlton and Presque Isle.

Raw Materials. Major ones are coal, marine clays, sand and gravel, feldspar, mica, burnt lime, peat, beryllium concentrate, columbium-tantalum, quartz, high grade pyrite-pyrrhotite, manganese-bearing iron, diatomaceous earth, pulpwood. Eighty-seven percent of the land area is forested.

Water Supply. Process water in quantity is generally available. Detailed technical surveys of ground water resources and supplies are currently underway by U.S. Geological survey.

Power and Fuel. Installed generating capacity for all electric utilities for 1959, (rated capacity in KVA) is 817,753. Undeveloped hydro-electric power sites have an estimated potential of 750,000 hp generating capacity. Price of propane gas is about 12¢ per gallon at Portland, using 250,000 gallons per year. Bunker C fuel oil, $2.79 per 42 gallon barrel delivered in Portland terminal.

State Speaks. There are leading chemical companies already located in Maine, and the resources still untapped are a rich source of potential development. Many excellent sites are available for chemical plants near the coast. The barge method of water transportation is an economical way of transporting both raw materials and finished product. The labor supply is very adaptable, and an ample number of workers are available. The University of Maine Chemical Engineering Department turns out engineers, although a large percentage of them work in other areas. The Maine Department of Economic Development has a list of chemical engineers and chemists who are interested in employment in Maine. The state offers aid in financing new industrial plants through the Maine Industrial Building Authority and the Development Credit Corporation of Maine. The excellent turnpikes between Maine and New York and Philadelphia, and the Air Transport Service available between these points, make the area most accessible to markets. #

MARYLAND

Industrial Tax Structure. State tax rate on real and personal property is $0.1375 per $100 of assessed value. Real property generally assessed at 50-60% of current sale price, except in Baltimore City where rate is 60-65%. Inventory assessed at 100% of cost or market, whichever lower. Machinery and equipment assessed at 100% of depreciated value. Depreciation allowed at 10% per year to minimum of 25% of cost. Corporate income tax 5% of net income allocable to Maryland. Special Provisions: Sales and Use tax of 3% does not apply to manufacturer's purchase of raw materials nor generally to his purchase of fuel, power, or steam. Foreign corporations pay $25 qualifying fee and $25 annual fee when annual report filed with State. Counties and cities empowered to exempt from taxation inventories, machinery, and tools. If local jurisdiction makes exemption, state does likewise.

Transportation. Leading railroads are: Pennsylvania—468 miles; Baltimore & Ohio—318 miles; Western Maryland—280 miles. The Port of Baltimore has been second foreign trade tonnage port in U. S. during 11 of last 13 years. Inland water transport through the Chesapeake and Delaware Canal, which connects Chesapeake and Delaware Bays. Modern highway network.

Raw Materials. Maryland is limited in large-scale raw materials because of its size. However, limestone, clay, coal, natural gas, and sand are available to the chemical industry.

Water Supply. Ample sources of industrial water over entire state. No unusual aspects in air and stream waste disposal laws.

Power and Fuel. Typical monthly industrial power billings (Baltimore) are: $1,440 for 300 kw demand, 60,000 kwhr consumption: $6,345 for 1,000 kw demand, 400,000 kwhr consumption. Unlimited natural gas supplies; rates depend on specific locations.

State Speaks. Maryland is strategically located to serve the gigantic consumer and industrial markets in the Eastern U. S. The East Coast states produce about 45% of the nation's industrial output—Maryland is located squarely in the center. Major element is the market around New York City, which can be served by overnight shipment, avoiding high land and labor cost in that area. Some 80% of the state's industry is located in the Baltimore metropolitan area which ranks fourth on the East Coast in industrial employment and value added by manufacture. Maryland is equally well situated to serve the rapidly-growing Southeast industrial area. Baltimore is a center of chemical manufacturing; several plants are the largest of their type in the world. Chemical facilities include a sulfuric acid plant, a superphosphate plant, a bichromate plant, and one of the country's largest and most modern titanium dioxide plants. Baltimore is the world's largest fertilizer production center. A versatile and well-trained labor force is available, particularly in the Baltimore area. The state has an enviable record of few work stoppages of local origin.

MASSACHUSETTS

Industrial Tax Structure. Corporate excise tax of 5.50% based on net income allocated to Massachusetts. Corporate excess tax against fair value of all the corporation's capital stock, less certain specific deductions, or based on value of tangible property and not taxed locally, whichever greater; rate is $5.00 per $1,000 of valuation. Surtax of 23%, making effective rate on income 6.765%, and on corporate excess $6.15 per $1,000. Taxes at municipal level less than in most states. Special Provisions: state unemployment compensation tax operates on "experience rating" system to determine rates for individual employers; state tax on production machinery and inventory is $5.00 per $1,000, no local tax.

Transportation. Leading railroads are: New York Central—709 miles; New York, New Haven and Hartford—1,200 miles; Boston & Maine—2,886 miles. Major ports for ocean-going vessels are Boston, Gloucester, Salem, Newburyport, New Bedford, Fall River. Port of Boston, one of the ranking ports in U. S., is nearest major Atlantic port to Europe, Africa, East Coast of South America, has all necessary services, such as warehousing, cold storage, class I railroads, foreign trade banks, freight forwarders.

Raw Materials. No major deposits of raw materials suitable for the chemical industry.

Water Supply. Sufficient ground water supply in virtually all parts of the state. Air and stream pollution regulated by law, but no unusual provisions.

Power and Fuel. Typical electric power rates for the Boston area are: Demand charge—$146.00 per month for first 50 kw of demand; $2.35 per kw per month for next 250 kw; $2.15 per kw per month for next 500 kw; $2.00 per kw per month for next 2,200 kw; $180 per kw per month for excess. Energy charge—2.8¢ per kwhr for first 4,000 kwhr per month; 1.7¢ per kwhr for next 16,000 kwhr per month; 1.3¢ per kwhr for next 100,000 kwhr per month; 1.05¢ per kwhr for excess over 120,000 kwhr per month. Fuel rate is flexible depending on fuel and location.

State Speaks. Incentives for chemical industry location in Massachusetts are: 1) Unexcelled colleges and universities with seminars, colloquia, consultanta, special courses, basic research and laboratory facilities for use of industry. 2) Supply of highly skilled and efficient workers on all levels. 3) Pool of expert consultants which can be tapped when need arises for specialized services. 4) Quality and purity of water supply generally eliminates cost of purification. 5) Industrial research facilities which can handle any and all technical problems, making it unnecessary to tie up capital in laboratory equipment. 6) Excellent transportation system and modern highway network. 7) Unequalled living conditions for both work and play.

MICHIGAN

Industrial Tax Structure. Major industrial tax is general property tax on real and tangible personal property levied by local government units, not the state. This tax varies depending on location, thus average tax rates might differ widely from the true tax. There is a constitutional limit of 15 mills on the rate of taxation, however, home rule cities are limited by charter, not state constitutional limits. A business activities tax on business having gross annual receipts of $25,000 or more is paid at .775 of 1% on adjusted receipts. A corporation franchise tax of 5 mills upon each dollar of its paid-up capital and surplus is paid annually. Other state levied taxes include an intangible personal property tax, a corporation organization tax (0.5 mills per dollar of authorized capital stock plus a filing fee to $10), and unemployment compensation tax.

Transportation. Thirty-two railroads operate in state over a network of 6,954 miles of mainline track. Railroad car and ferry routes run across Lake Michigan between large cities. Michigan has 19 million-ton ports; 9 are bulk cargo shipping ports, 7 are major receiving ports, and 3 are car-ferry ports. St. Lawrence Seaway opens ports to ocean-going vessels. Major ports: Detroit, Port Huron, Bay City-Saginaw, Muskegon, and South Haven.

Raw Materials. State is leader in production of salt, gypsum, peat, and natural saline compounds; second in limestone; also produces lime, glass sand, petroleum, and natural gas.

Water Supply. Surface water from Great Lakes is abundant, underground water readily available. Great Lakes water has moderate hardness, except Lake Superior (soft). Inland water is moderate to hard.

Power and Fuel. Average typical industrial electric bills are as follows: $711 for 150 kw demand and 30,000 kwhr consumption; $1,273 for 300 kw, 60,000 kwhr; and $3,714 for 1,000 kw, 200,000 kwhr. The average cost per therm (100,000 Btu) is 5.57¢.

State Speaks. Michigan is a natural location for chemical industries because of its wealth and variety of natural resources such as its salt and brines, its petroleum, and other minerals. This is pointed out by the location of the headquarters of Dow Chemical Co. Other large chemical companies are Wyandotte Chemical, Pennsalt Chemicals Corp., Allied Chemical and Dye. In addition, a growing chemical complex at White-Hall-Montague was started by Hooker Electrochemical and joined by DuPont and Union Carbide. The state is situated to serve one of the most highly concentrated market areas in the world—that of the Great Lakes states. The St. Lawrence Seaway provides economical bulk cargo transportation to all ports of the world. Michigan's widely known state supported universities provide a large source of managerial and scientific manpower to oversee the work of the varied skilled labor available in the state. #

MINNESOTA

Industrial Tax Structure. Chief source of state tax revenue is the income tax on both individuals and corporations. Normal corporation income tax rate is a flat 7.5%. If income is from business only partly within the state, a formula based on sales, property, and payroll is used to allocate portion taxed in Minnesota. Temporary additional tax (1959-60) on corporations for school fund at rate of 1.8%. Ad valorem property tax based on statutory percentage of "true and full value." Assessments vary in general between 20 and 50% of full value. No special plan in Minnesota to induce location or expansion through tax advantages.

Transportation. Total of 26 1st and 2nd class railroads. Main lines are: Chicago, Milwaukee, St. Paul & Pacific —1,676 miles; Chicago North Western—1,386 miles; Duluth Mesabi & Iron Range—1,133 miles; Great Northern—2,975 miles; Minneapolis, St. Paul & Sault Ste Marie—1,253; Northern Pacific—1,971 miles. Total railroad mileage in state—12,517 miles. Duluth is major port for ocean-going vessels and for access to inland waterways.

Raw Materials. Huge surplus of pulp woods for paper manufacture. Reserves of silica sand, kaolin clay, limestone and marl.

Water Supply. In general available in unlimited quantities both ground and surface, under 50°F year round. Some problem areas in Red River Valley, the Mesabi Iron Range, and some of southwestern Minnesota. No unusual waste disposal laws.

Power and Fuel. Industrial power rates are: Demand charge for secondary voltage service is $1.90 per kva

per month for 1st 100 kva of demand, graduated down to $1.27 for excess over 200 kva of demand. Discounts for primary and high voltage service. Energy charge is from 1.75¢ per kwhr for 1st 10,000 kwhr per month down to 70¢ for excess over 2,000,000 kwhr per month. Gas rates from 57¢ per 1000 cu. ft. for small quantities to 31.5¢ for 50 million cu. ft. per month and more.

State Speaks. With coming of major crude oil, natural gas, and petrochemical pipelines from Canada, a huge expansion of the chemical industry in Minnesota seems inevitable. Growth of the chemical process industries has been spectacular in recent years. For example, there has been a 100% increase in value added by manufacture in its pulp and paper industry in the past ten years. Petroleum refining capacity has increased eightfold in the past six years, further rapid expansion is anticipated. With this increase in refining capacity will come opportunities in the petrochemical field in polyethylene, polypropylene, butadiene, perhaps synthetic rubbers. Added to the state's favorable situation in raw materials and available utilities, is the existence of an ample supply of trained labor. #

MISSISSIPPI

Industrial Tax Structure. General property tax for state, county, municipal, and district revenues according to rule of uniformity prescribed by state Constitution. Assessment practices vary among counties, average assessed valuation is about 25 to 30% of true value; average tax rate runs about 60 mills inside municipalities and 50 mills, total, outside. These rates include ad valorem tax on real and personal property, collected on basis of county assessment. Exemption may be five years from county, and ten years from municipal, taxes on practically all manufacturing property, except inventory of finished goods. Corporate organization and qualification fee based on capital stock: $20 for $5000 or less; plus $2 per $1000 over $5000 (max. $500). Corporate franchise tax on book value of capital stock, $2 per $1000 (min. $10). Severance tax on gas, oil, and timber; unemployment compensation from 1.5 to 2.7% on experience basis. State "Balance Agriculture With Industry" plan provides special inducement to industrial plants.

Transportation. Nineteen railroad lines with over 4000 miles of track serve the state; four major interstate superhighways cross the state; three airlines stop at 12 principal cities. Two deep water ports, Pascagoula and Gulfport, and several barge lines on the Mississippi link with the intercoastal waterway.

Raw Materials. Mississippi ranks among the first ten petroleum producing states. Natural gas, lignite, and some coal round out its organic raw materials. Inorganic materials include limestone, salt and brines, gypsum, sand, silica, and clays. Its forest and wood by-product potential has hardly been tapped.

Water Supply. No areas lack adequate amounts of industrial water; ten watersheds in state. Stream pollution law administered by State Game and Fish Commission may require effluent analysis; Mississippi river not subject to law.

Power and Fuel. Electric power supplied by two private utilities and TVA. Current capacity greater than demand; situation will remain same for many years. Rates comparable to neighboring areas run about $350 for 15,000 kwhr at 75 kw demand to about $4500 for 400,000 kwhr at 1000 kw demand per month. Natural gas available from local wells.

State Speaks. Mississippi has a large, currently undeveloped chemical industrial potential. The state needs a chemical industry for vertical integration of forest products. Presently, millions of dollars are being lost due to lack of good engineering practices . . . . the field is ripe for development. In addition to the resources named above, bentonite, Fuller's earth, tripoli, bauxite, and iron ore are all present in quantities suitable for commercial development. There is a large reservoir of unskilled labor available for industrial production. The absence of industrial plant concentration and non-use of high-carbon fuels make for air relatively free of soot, ashes, and other impurities.

MISSOURI

Industrial Tax Structure. Corporation franchise tax and annual registration fee: 1/20 of 1% par value capital stock and surplus of property and assets in state. Income tax: 2% annual net income from business in state—federal tax deductible. Intangible property taxed 4% on yield. General property tax averages 3% on valuation of real and intangible property; communities assess, generally, at 30% of book value. Ad valorem at same rate as general property tax, based on value of highest amount of raw materials in first quarter of year. State ranks second lowest in state and local taxes per $1000 of income. Tax structure was designed, and has been modified, with the manufacturer in mind.

Transportation. Fifteen Class I railroads operate on over 7000 miles of main-line track in Missouri. No ocean-depth ports, but several major cities line the courses of the Missouri and Mississippi rivers in the state.

Raw Materials. Missouri leads the nation as producer of tripoli; state also produces slightly over 6% of nation's coal and lignite. Also found: lead, magnetic iron ore, clays, shale, limestone, barite, silica sand, and silver. Exploratory petroleum drilling not yet producing sufficient quantities for commercial development.

Water Supply. Ample over-all water supply, with moderate-to-large ground water supplies available in southern part of state. In northern part of Missouri, abundant supplies are available only along major streams or in buried pregiacial valleys. Each new plant is subject to individual consideration by the State Water Pollution Control Board.

Power and Fuel. Industrial electric power rate for heavy industries: 15.1 to 9 mills per kwhr; light industry

ranges from 15 through 20 mills per kwhr. However, private contracts are almost always negotiated between the industry and the utility. Fuel rate on a Btu basis runs: coal—0.03 mills; oil—0.05 mills; and gas—0.07 mills.

State Speaks. Among the several advantages to potential site-seekers in Missouri are: its central location with regard to industrial and consumer markets; lower transportation costs because of central location and proximity to the country's two largest navigable rivers; abundant water for processing; diversity of present manufacturing in the state; abundant labor; healthy business climate; and recreational facilities. Favorable business climate involves a taxation program which is reasonable and which provides complete governmental services, while the per capita tax burden is one of the lowest in the country. The variety in types of available water can promote a variety of industrial uses. The alluvial supply in the Missouri and Mississippi river basins offers a vast quantity of water for heavy industrial users, particularly in the chemical processing field. There are already a sizable number of firms in the state which produce basic chemicals and components for the industry.

MONTANA

Industrial Tax Structure. Corporation income tax is presently 5% on net taxable income, with a minimum of $10. Federal income taxes are not allowed as deductions in determining net income. Starting January 1, 1961, the rate will be reduced to 4½% of net taxable income. An unemployment program is financed by employer contributions which are set by a commission for each employer according to classifications. Maximum participation is 2.7% of payroll on the first $3000 per year of wages and salaries for each employee. About sixty percent of revenues in Montana come from property taxes. Most property is assigned a taxable valuation of between 20 and 33⅓% of the "true and full value" as determined by the local assessor. The average levy for counties in fiscal 1958 was 93.51 mills, and the average for cities was 149.89 mills. There are no special tax exemptions or inducements to industry; however, "true and full value" appraisal is normally set at less than 40% of actual value. Montana has no general sales or use tax.

Transportation. Main railroad lines are: Northern Pacific; Great Northern; and the Chicago, Milwaukee, St. Paul & Pacific; Union Pacific; Burlington Route. Total mileage in Montana is 4,995 miles. No water transportation system either ocean-going or inland.

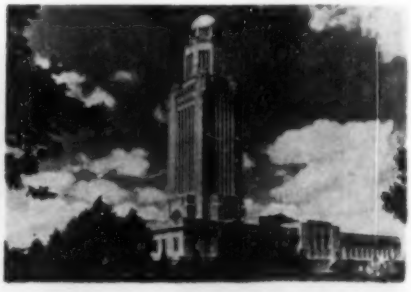
Raw Materials. Petroleum, coal, arsenic, antimony, barite, bentonite, chromium, fluorite, graphite, gypsum, kyanite, andelusite, sillimanite, lead, limestone, manganese, phosphate, sodium sulfate, sulfur, talc, wood and agricultural products.

Water Supply. Montana has an abundance of cold, high-quality water for industrial use. There are no unusual waste disposal laws.

Power and Fuel. The prevailing industrial electric power rate is from 2 to 9 mills per kwhr, depending on location and usage. Prevailing rate for gas is 35¢ per million Btu, coal—7-29¢ per million Btu, fuel oil—25-50¢ per million Btu.

State Speaks. A great increase in Montana-based chemical industry is anticipated as the state's vast and varied resources are developed. A good nucleus of chemical plants has already been attracted. Some, already established, are: oil refining, production of elemental phosphorus, sulfur, and sodium dichromate. Montana's rapidly expanding pulp and paper industry will provide a growing market for a wide range of chemicals. Other chemical-consuming industries are now considering Montana as a good potential location for supplying the expanding markets of both the Missouri Basin and Pacific Northwest areas. All of Montana's larger cities, and many of the smaller communities have initiated planning and zoning studies, and are now prepared to welcome industrial inquiries. #

NEBRASKA



Industrial Tax Structure. Property taxation in Lincoln for 1959-60 was $77.56 per $1000 assessed value. Legal level of assessment is 35% of actual value. Actual level on real estate is 25% at present, and about 32% on inventories. Domestic corporations pay an occupation tax based on paid-up capital stock. Fee is $5 for less than $10,000 capital and is scaled up to $1200 for over $10 million. Foreign corporations pay an occupation tax based upon assets in Nebraska. The fee ranges from $5 for less than $10,000 to $400 for assets in excess of $900,000. State has no income or sales tax. Taxes in state are usually lowest or next to the lowest when based on taxes per capita.

Transportation. Major railroads include: Chicago, Burlington and Quincy (2644 miles of track); Chicago & Northwestern (1221 miles); Missouri and Pacific; Union Pacific; Chicago, St. Paul, Minneapolis and Omaha; Chicago, Milwaukee, St. Paul and Pacific; Chicago, Rock Island and Pacific; Illinois Central; Wabash; Chicago and Great Western; and Santa Fe. Major ports on Missouri River are Falls City, Nebraska City, Omaha, and Sioux City.

Raw Materials. Nebraska is 14th in production of oil. The state also has the following raw materials: gas, silica, and potash.

Water Supply. There are no areas within the state where industrial water supply is a problem. The Missouri on the eastern border, and large underground supplies of water, can meet the needs of industry.

Power and Fuel. Typical industrial electric bills for 75 kw billing demand are $264 for 15,000 kwhr and $348 for 30,000 kwhr. For 300 kw billing demands, the monthly costs are $825 for 60,000 kwhr and $1130 for 120,000 kwhr. The costs for 1000 kw demand are $2522 for 200,000 kwhr and $3541 for 400,000 kwhr.

State Speaks. Nebraska is, and will most likely remain, an agricultural state, However, since agriculture should not be the only basis for an economy, the various cities of the state have been striving to enhance their industrial position. While there are very few large chemical plants presently in Nebraska, there are many definite advantages for such plants in the state. The huge agricultural midwest, of which Nebraska is the focal point, offers a wonderful market for chemical industries that supply the needs of agriculture, and that make use of agricultural products. For example, corn cobs supply the needs of the Quaker Oats furfural plant in Omaha. Industry can look forward to an ideal business climate in Nebraska. The state offers an abundance of labor and water, a huge market for agricultural chemicals, favorable labor laws, water transportation by barge on the Missouri River, lower taxes, and cooperation by the individual cities. #

NEVADA

Industrial Tax Structure. State, county, and local property taxes limited by Nevada's Constitution to a total of $5.00 for each $100.00 of asssessed valuation. Assessments average 30% of actual value throughout the state. Two percent sales tax in effect. The state has maintained a cash surplus in the treasury for many years, and anticipates no increase in taxes in the foreseeable future. Special Provisions: Freeport Law insures that anything manufactured, assembled, or stored in the state for ultimate distribution outside the state is free of any tax.

Transportation. Geographical location of Nevada makes it a natural transportation hub for the eleven western states. Leading railroads are: Southern Pacific—300 miles; Western Pacific—300 miles; Union Pacific—100 miles. Nearest major port with facilities for ocean-going vessels is Stockton, California, 150 miles away. No inland waterways. Numerous trucking organizations provide excellent internal transportation facilities.

Raw Materials. Chief raw materials available to the chemical industry are metallic oxides, beryllium, titanium, zinc, lead, gold, silver, and copper.

Water Supply. No comprehensive data are presently available on water resources. However, a survey on underground water is presently underway, results should be available shortly.

Power and Fuel. Power rate varies from 5 mills to 6¢/kwhr, depending on location. Fuel rate also varies depending on location. Natural gas is available in southern Nevada, manufactured gas in remainder of state.

State Speaks. For many years, the State of Nevada has been considered a playground with little or no interest in industrial development. However, on entering office on January 1, 1959, the present Governor, Grant Sawyer, emphasized that the economy of the state should be diversified to strengthen the already prosperous tourist economy. Chemical companies already having production facilities in Nevada include such industry leaders as Stauffer Chemical and American Potash. Nevada will be happy to assist in the location of additional chemical industries within its borders. Incentives to such location can be summarized: 1) Extremely favorable tax structure for industry. 2) Strategic geographical location for distribution in the western states. 3) Ample pool of labor available for chemical industry. Right-to-Work law contributes greatly to favorable labor climate. Labor difficulties are rare. 4) Numerous areas within the state where land is available either free or at very small cost. Good transportation network, including three major railroads and many trucking lines.

NEW HAMPSHIRE

Industrial Tax Structure. New Hampshire has no corporate income tax, use tax, or any other tax levied on industry except for nominal corporation registry fees. Ad valorem taxes are levied on land and buildings, machinery and inventory. Inventory includes raw materials, goods in process, and finished products. The tax is based on average value to manufacturer of inventory over a 12-month period. Rate and basis for assessment are the same for land and buildings, machinery and inventory. Average 1959 tax rate in the state was $5.37 per $100 valuation. Average property value was 51% of market value. Average tax net rate was $2.74 per $100. There is no special tax plan for industry.

Transportation. The leading railroad in the state is the Boston and Maine Railroad, 941.84 miles. Portsmouth is New Hampshire's only port. A long range program of harbor improvements, now underway, will make the port increasingly accessible to ocean-going vessels. Other railroads running through the state are the Maine Central, Suncook Valley, and Grand Trunk.

Raw Material. While there are few raw materials sources actually located in the state, they are readily available through the transportation system.

Water Supply. The supply of industrial water is adequate for all purposes in the state. There is no area in which it is considered a problem.

Power and Fuel. Average rate for process industry would be about 1.55¢ per kwhr. This would vary with load factor and size of demand. Typical electric power billings as of January 1, 1959: 300 kilowatt demand, 120,000 kwhr, $1711. For 100 kilowatt demand, 400,000 kwhr, $5649 in the city of Concord. Manchester and Nashua, for the same amounts, run $1766 and $5220. Prevailing fuel rate, on a Btu basis, is $.00084 (bituminous coal).

State Speaks. New Hampshire's two principal attractions for the chemical industry are its location, in the highly industrialized and densely populated Northeast near a large and rich market, and its only port, Portsmouth. This city has some of the few remaining deep-water industrial sites on the Atlantic coast. These sites will be increasingly accessible and usable to ocean going vessels when the improvement program is complete. The current trend toward establishment of petroleum refineries near markets, rather than oil fields, makes the possibilities for refineries in the Portsmouth area excellent. The same industrial advantages which have made New Hampshire the second most industrialized state in the nation, are available to support manufacturers of chemical specialty products. Also, the favorable tax structure, good industrial sites and water, and a labor force conditioned to manufacturing employment, are additional advantages.

NEW JERSEY

Industrial Tax Structure. Corporation franchise tax on net worth at end of base year allocable to state. Entire net income allocable to state (effective for tax payable in 1959 and thereafter). Rate on net worth base: 2 mills per dollar on first $100 million; 0.4 mill per dollar on second $100 million; 0.3 mill per dollar on third $100 million; 0.2 mill per dollar on all over $300 million. Minimum tax, the greater of 0.5 mill per dollar on first $100 million and 0.2 mill on excess over $100 million of allocated assets and $25 for domestic corporations, $50 for foreign corporations (tax on net worth only). Rate on entire net income base is 1¾%. Major portion of taxes paid by industry is on real and personal property, and is imposed by the municipality where the plant is located. Assessments and rates vary with the town.

Transportation. Nine major rail systems plus eleven minor systems have a total of 2,011 miles in New Jersey. Leading railroads are: Pennsylvaina—420 miles; Pennsylvania-Reading—369 miles; Central Railroad of New Jersey—409 miles. Major ports for ocean-going ships are: Port of New York; Port Newark; Port Elizabeth; and the Delaware River Ports.

Raw Materials. Magnesium compounds, silica sand, clays, zinc, iron, by-product sulfur, limestone, ilmenite, and greensand marl, of which New Jersey is the sole U. S. producer.

Water Supply. Ample supply for industrial use. Nineteen reservoirs with total storage capacity of 65 billion gallons. Ten-year hydrological survey under way to safeguard water resources.

Power and Fuel. Typical monthly electric power billing: 300 kw demand, 120,000 kwhr consumption—from $1,584 to $1,746 depending on percentage of power used during night hours. For 1,000 kw demand, 400,000 kwhr consumption—from $4,856 to $5,261, (for cities of 50,000 population or more). Fuel costs vary with the four power utility companies in the state.

State Speaks. New Jersey is the nation's leading producer of chemicals and chemical products, with a value added by manufacture of $1,467,071,000. New Jersey's attraction for chemical plant location can be summed up: 1) A market of 31% of the nation's population in an overnight delivery range of 250 miles. 2) Great diversification of labor skills. 3) Excellent research and educational centers, professional chemical societies and associations in close proximity to manufacturing facilities. Ten percent of nation's research conducted in New Jersey. 4) Natural water boundries with the deep-water ports of New York, Newark, Philadelphia. 5) Unexcelled transportation system of highways, railroads, and airports. 6) Abundant electric power, gas, and pure water. 7) Favorable tax climate, no state income or sales tax. 8) Ideal residential living, city or suburb. #

NEW MEXICO

Industrial Tax Structure. Coporate income tax is a flat 2%, with federal taxes deductible. Raw material and new plant equipment being moved into the state are exempt from the compensating tax of 2%. Manufactured items are exempt from the 2% sales tax, unless sales are made directly to the ultimate consumer. There is a constitutional limit of twenty mills per dollar of assessed value for general purposes. Assessment ratio is one-third of actual value. Book value is usually acceptable as actual value. Under the Industrial Revenue Bond Law, firms locating in the state are exempt from all state and local taxes. This also includes certain federal levies. The state has no special taxes on raw materials used by a plant, or on finished products.

Transportation. Leading railroad is Atchison, Topeka, and Santa Fe with 2,259 miles. Others are Chicago Rock Island & Pacific—200; Colorado & Southern Railway—95; Denver & Rio Grande Western—111; Southern Pacific—951; and Texas-New Mexico—73. Incoming shipments are received from ports on the Texas Gulf Coast and Southern California.

Raw Materials. New Mexico ranks first in potash and uranium; second in manganese, beryl and perlite; fifth in copper; sixth in oil and natural gas. It is also an important producer of gold, silver, lead, zinc, selenium, vanadium, iron, columbium, rare earths, mica, barite, salt, pumice, molybdenum, and scoria.

Water Supply. A problem in desert lands. In other areas, large quantities of surface waters have been reserved for industry use. Water may be developed from new ground sources or by appropriation from the state engineer, or by retiring existing water rights.

Power and Fuel. In Albuquerque, electricity is 1¢ per kwhr on all over 200 kwhr, to six-tenths of a cent per kwhr on all over 400 kwhr. On large quantities of industrial gas, rates are commonly set on a negotiated basis. Interruptible service rate in Albuquerque begins at 25¢ per 1000 cu. ft.

State Speaks. Any new firms moving to the state are eligible for services from the State Department of Development, an agency set up in 1959 to assist companies with expansion plans in the state. It conducts confidential surveys in the areas of finance, labor, sites, taxation, and markets, and performs other factory locating services. Financial assistance for new plant construction, and, in many areas, donated land, is available. New Mexico's highly developed network of mineral extraction facilities, and the fact that extraction of raw materials is now economically matured, make the next step logical. That is expansion in conversion of raw materials into finished goods. The state is strategically located with respect to Far-West and Mid-West markets, and in the center of the growing Rocky Mountains and Southwest marketing areas. The population of the state has increased 50% since 1950. The labor supply is excellent, and a surplus of people skilled in manipulative tasks is available. An industrial climate has been created both on the state and local level that is extremely favorable to the creation of new chemical plants. #

NEW YORK

Industrial Tax Structure. Taxes based on business profits, not on gross business. No state property tax, but municipalities do levy such taxes locally; range is 2 to 4 mills on full value. Unincorporated business income tax: 4% on net income, $5000 exemption for personal services each proprietor. All professional income exempt. Franchise (corporate net income) tax: ½ mill per $1 of allocable subsidiary capital up to $50 million; ¼ mill next $50 million; ⅛ mill each dollar over $100 million, plus one of following alternatives: 5½% on portion allocable to state; 5½% of a base computed by formula; 1 mill per $1 value of business; or $25, whichever is greatest. Corporate organization fee: domestic—1/20 of 1% face value aggregate stock, min. $10, plus $40 incorporation fee; foreign—⅛ of 1% face value issued stock, min. $10, plus $110 certificate of authority. Unemployment insurance 0-3.2% of individuals' first $3000 wages.

Transportation. Forty rail lines with about 6900 miles of track in state. Port of New York is country's largest. Ocean-draft vessels reach 150 miles up Hudson to Albany; barge canal connects Hudson with Great Lakes. Buffalo largest Great Lakes port; Oswego, Sodus Bay, and Rochester front Lake Ontario; Ogdensburg and Waddington on St. Lawrence. Plans in works will link Hudson to Lake Champlain and thence St. Lawrence.

Raw Materials. New York ranks third in both salt and limestone production; leads nation in rock salt production. Other chemical potentials include: gypsum, talc, clay, zinc, iron ore, titanium, wollastonite, wood pulp, gas, and petroleum.

Water Supply. Every section of state has adequate water. Regulations exist for future conservation. Water classified according to grade of usage. Jurisdiction under State Water Control Commission. Discharge of industrial waste supervised by Water Pollution Control Board. Special situation in Nassau and Suffolk on Long Island requires return of ground water taken out for industrial use.

Power and Fuel. Power in state generated largely from fossil fuels, therefore cost slightly higher than in hydropower states. Range is $300 to $400 for 15 kwhr at 75 kw demand, to $7000 for 400,000 kwhr at 1000 kw demand. Highest rates in New York city area. St. Lawrence and Niagara power will run 4 to 6 mills per kwhr. Coal 35¢ per million Btu; natural gas 52¢ per million Btu; #6 oil 41¢ per million Btu.

State Speaks. Cheap water-borne transportation for bulk cargoes, and large bodies of fresh water for industrial use, are prime assets. New blocks of hydroelectric power at Niagara Falls and St. Lawrence prove attractive to chemical companies. Two compelling reasons for plant location are easy access to markets, and large numbers of scientific and technical personnel available. More than half the country's industrial plants are concentrated in northeast; more engineers and scientists graduated from New York institutions than from those of any other state. Last, but also important, is NYC concentration of advertising, engineering, and professional services.

NORTH CAROLINA

Industrial Tax Structure. State taxes are a franchise tax, an income tax, and a small sales tax. Franchise tax rate is $1.50 per $1,000 of the largest of: (a) the portion of the capital stock, surplus, and undivided profits allocable to the state; (b) the assessed value of property in the state, including intangible property subject to taxation; or (c) the book value of real and tangible property in the state. Income tax of 6% on portion of net income allocable to state. Wholesale sales tax rate is 5¢ per $100 on raw materials, fuel, industrial equipment when purchased within the state only. Average county-wide tax rate (1957-58) was about $1.14 per $100 of assessed valuation of property. Average assessment about 40% of market values. No special provisions or tax exemptions in North Carolina.

Transportation. Main rail lines include: Atlantic Coast Line, Seaboard Air Line, Atlantic and East Coast Railway (subsidiary of Southern Railway System). Two main ocean ports are Wilmington and Morehead City, with depths of 34 and 30 feet respectively (mean low water).

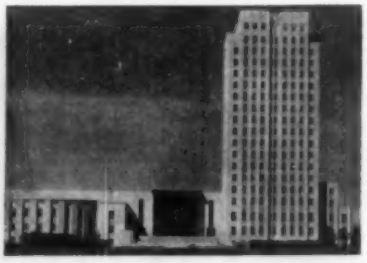
Raw Materials. Lithium (estimated 80% of known U.S. reserves). Phosphate materials (estimated 30 billion tons in Beaufort County). Also reserves of chemical-grade coal, shale, olivine, sulfides, clays. Wilmington, N.C., said to be best location on Atlantic Coast for extraction of chemicals from sea water.

Water Supply. Generally ample. Surface water throughout state, very large ground water supplies in eastern part of state.

Power and Fuel. Typical urban industrial power rates (1959) are: Monthly billing for 300 kw demand, 60,000 kwhr consumption—$825; for 1,000 kw demand, 400,000 kwhr consumption—$3,689. Fuel rates vary depending on fuel and location.

State Speaks. North Carolina is in a state of rapid transition from an agriculture-based economy to one centered on heavy industry, is already the largest industrial state in the South. An equable climate, winter and summer, strategic geographical position, and an ample supply of intelligent labor assure its industrial future. Trump card is the Research Triangle in the heart of the state. The Triangle consists of the University of North Carolina in Chapel Hill, Duke University in Durham, and the North Carolina State College of Agriculture and Engineering in Raleigh. There are currently more than 850 research people on the staffs of these three institutions, which have a total budget of more than $7 million for organized research. Investment capital for development of new industries is available within the state. North Carolina life insurance companies have total resources of more than a billion dollars, banks more than $3 billion.

NORTH DAKOTA



Industrial Tax Structure. Corporate income tax is 6% on net income over $15,000. There is no corporation business tax, no franchise tax. A 5% tax on gross value of wells from which oil and gas are produced. Property is taxed under a statute requiring that assessments be at 100% of full value, and tax is computed on 50% of assessed value. Assessed valuation in most communities is one-third of real value. Mill levy, for example, in Fargo is 143.15; Minot, 167.50; and Bismarck, 153.39. Under the Freeport Law, a general property tax is not imposed on goods moving in interstate commerce through the state, nor on goods brought in for storage, re-packaging, assembling, or processing, if they are to be re-shipped out of the state.

Transportation. Total rail mileage as reported in 1958, was 5279. Leading railroads are: Great Northern; Northern Pacific; the Soo; Chicago, Milwaukee; and Midland Continental. Closest major port is at Duluth, Minnesota. This is only some 200 miles east of the eastern boundary of the state. Barge facilities are reached readily on the Mississippi at Minneapolis, 250 miles southeast of Fargo. Highways connecting with principal cities are excellent.

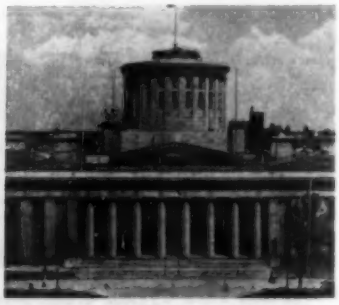
Raw Material. Crude petroleum, lignite (North Dakota has 75% of the U.S. lignite reserves and 41% of world reserves), sodium chloride (eleven major salt beds), sodium sulphate, clay, sulfur. Other materials: bentonite, leonardite, limestone, sandstone, fuller's earth and quartzite.

Water Supply. Good industrial water from the Missouri River flows through the western part of the state. Garrison Reservoir is on the Missouri, in the west central section. Red River for smaller amounts in the eastern part. These are the best parts of the state for water.

Power and Fuel. 1.6¢ kwhr for over 10,000. Typical bill for 1000 kilowatts, 400,000 kwhr, is $6721 in Fargo. Current rate on natural gas is 39¢ per 1000 cu. ft., for users of over 6 million cubic feet a month, 34¢. This is rated at 1040 Btu's per 1000 cu. ft. Industrial fuel oil is 12.2¢ per gal. No. 1 diesel.

State Speaks. There is an abundance of raw materials for many basic chemical operations. Low cost industrial sites are available adjacent to many of the principal cities of North Dakota. Real estate taxes are low. Most land has an average tax of $1.00, as compared with $5 to $6 an acre in other states. The workers are known for their resourcefulness and ability to learn rapidly. Many of them come from farms where they have developed a high degree of mechanical aptitude, and quickly adjust to industrial activity. Absentee rate among workers is low. There are fewer interruptions in plant operations due to weather and traffic conditions than in any other section of the country. Some communities have organized industrial development corporations, where funds are available to assist firms wishing to establish industry in the area. Other communities have organized Community Betterment Committees to provide information. #

OHIO



Industrial Tax Structure. Corporate organization or entrance fee based on number of authorized shares of capital stock: 10¢ per share first 1000 shares to ¼¢ per share on excess of 500,000 shares; min. fee domestic corporations, $25; foreign—$50 plus above-named fee on capital stock. Corporation franchise tax: 3/10 of 1% (min. $50) of value of capital stock. General property tax varies according to value fixed by county auditor, limited to 1% assessed valuation. Tangible personal property taxed at either 50% or 70%; former rate on machinery & equipment, latter on furniture, fixtures, and supplies. Inventories taxed at 50% of value. Intangible property taxed 5% on productive income; 2 mills per dollar value unproductive investments. Unemployment tax 0 to 2.7% on individuals first $3000 wages. Municipalities tax corporation net profits from 0.3 to 1%.

Transportation. Ten rail lines share almost 9000 miles of track in Ohio. Cleveland, Toledo, Ashtabula, Conneaut, and Fairport provide facilities for ocean-going vessels on Lake Erie, while nine main cities front on the Ohio river.

Raw Materials. Salt and brine, lime, and coal are state's ranking chemical resources. Gypsum, pyrite, silica, clay, petroleum, and natural gas are also available to the chemical industry.

Water Supply. Industrial water is available throughout the state. State does not have stringent air and stream pollution laws, but zoning laws at local levels are sometimes stringent for a specific community or group of communities. Any state regulations available from Ohio Dept. of Health.

Power and Fuel. Nine electric companies serve Ohio, rates vary. Sample charges for southern part of state: primary rates for max. capacities in excess 50 kw; secondary for execss of 20 kw. Primary demand charge $87.50 for under 50 kw per month, scaled to $1.35 per kw per month for excess of 3000 kw. Energy charge first 20,000 kwhr per month, 1.6¢ per kwhr, scaled to 8.2 mills per kwhr for over 500,000 kwhr per month. Secondary demand rates start at $21.20 per month for under 10 kw, and run to $1.50 per kw per month for over 1000 kw demand. Energy charge starts at 2.2¢ per kwhr first 5000 kw per month, runs to 9.5 mills per kwhr over 100,000 kw per month. Six gas companies operate in state. Sample gas charge for same area above has 27.41¢ per 1000 cu. ft. base price, plus increase based on average of suppliers' charges to gas company.

State Speaks. One of state's greatest assets is proximity to market. Lake Erie and St. Lawrence Seaway provide access on north, Ohio river permits shipping to south, and major rails and highways cross Ohio. Over 50 colleges and universities turn out ample skilled labor force. Markets for chemical manufacturers in Ohio include steel, paper, soap and detergents, clay products, and rubber. Underground brine, low cost coal, availability of industrial quantities of water, and accessibility are main factors attractive to chemical process industry. #

OKLAHOMA

Industrial Tax Structure. Ad valorem taxes, based on about 20% valuation for industrial property, range from around 52 to 89 mills, with approximate average around 63 mills. Constitutional limit is 35% of actual value. Other taxes are: corporation organization fees ($1.00 per $1000 of authorized or allocated capital to be employed in Oklahoma); annual corporation franchise taxes ($1.25 per $1000 of capital employed in Oklahoma, max. $20,000); corporation income tax (flat 4%, federal income taxes deductible, for corporation in top federal brackets, this reduces to 1.92%). Cities and towns may grant 5-year exemption from municipal taxes for industrial property. Free tax port law of 1955 provides for temporary warehousing of goods in interstate commerce without assessment of property tax.

Transportation. Major railroads are: Atchinson, Topeka & Santa Fe—1233 miles; Chicago, Rock Island & Pacific —1062 miles; St. Louis-San Francisco—1421 miles. State has no ports or inland waterway access to ocean. Within the state are 17,000 miles of gas pipeline and 25,000 miles of oil pipeline.

Raw Materials. Oklahoma is fourth in production of crude petroleum, fourth in production of natural gas, and near the top in production of asphalt. Other raw materials are coal, selenite, sulfur, gypsum, lead, zinc, and limestone.

Water Supply. Unlimited water in east, limited supplies in west. Water Resources Development program has brought about considerable surface water impoundment in western Oklahoma. Also, a tremendous underground lake in the Panhandle is being drilled. State now has 1000 sq. mi. of inland water.

Power and Fuel. The rate per kwhr is around 6.5 mills assuming a load factor of 70-80%, a power factor of 100%, no fuel adjustment provisions, and demand of 10,000 kw or more. Natural gas for industrial purposes, 1025 Btu, costs around 19 to 21 cents per 1000 cu. ft. at present prices in the field, depending on the type of service.

State Speaks. Oklahoma's best opportunity for service to the chemical industry probably lies in the field of petrochemicals, although other chemicals can be, and are now being, produced (calcium carbide, sulfuric acid, sulfur, acetylene, etc.). Oklahoma has known reserves of 15 trillion cu. ft. of natural gas, and 2 billion barrels of petroleum. Its long history of refining operations has developed people with skills that can be adapted to petrochemical production. Transportation costs for heavier and low cost petrochemicals to northern and eastern markets may have a slight disadvantage. However, development of pipeline transportation methods for all sorts of commodities could overcome these disadvantages. No such disadvantage would accrue for lighter petrochemicals carrying higher values per unit either by rail or truck. #

OREGON

Industrial Tax Structure. Corporations are subject to a 6% tax on net taxable income. There is an offset of up to 1/3 of the tax to manufacturers for personal property taxes paid to local government units on raw materials, goods in process, and finished products. Industrial property must be assessed at same ratio to market value as other classes of property. There is no tax on intangibles; the property tax is levied on real estate and personal property (machinery and equipment, inventories, and office furnishings). Property taxes are reserved to local government, state relies on net income taxes. Tax rate on property is governed by the needs of the various taxing districts in relation to the assessed value of property in the district. Tax rate per $1000 of market value in Portland, for instance, is $24.62. In Salem, $22.58, and in Pendleton, $19.83. State constitution prohibits tax concessions to industry. There is a two year property tax exemption for unoccupied industrial buildings under construction.

Transportation. Total railroad mileage in state is 3,200. Leading railroads are: Spokane, Portland and Seattle; Southern Pacific; Union Pacific; Great Northern; and Northern Pacific. Major ports are Portland, Astoria and Coos Bay. There are eighteen others, including Alsea, Arlington, Bandon, Bay City, Brookings, Cascade Locks, Coquille, Gold Beach, Hood River, Nehalem, Newport, Port Orford, St. Helens, Suislaw. Barge travel on the Columbia to Pasco, Washington, and seasonally on the Snake River to Lewiston, Idaho.

Raw Materials. Wood waste and lime, sand and gravel, clay, silver, nickel ore, gold, mercury, iron ore, copper. Also, diatomite, mineral pigments, sodium carbonates, tungsten, uranium.

Water Supply. In most of the populated areas, chemically pure industrial water is plentiful. In the desert areas in the southeastern part of the state, industrial water is a problem.

Power and Fuel. Typical electric bills in 1958: 150 kilowatts, 60,000 kwhr, $541; 1000 kilowatts, 400,000 kwhr, $2,361 in Portland and Salem, slightly lower in Eugene Fuel: Bunker C, 151,781 Btu/gal. at $2.50/42 gal. bbl. or 2,549,921 Btu/dollar or $0.0392 per 100,000 Btu. Heavy fuel oil, PS400:151,341 Btu/gal. at $2.70/42 gal. bbl. Or, 2,504,459 Btu/dollar or $0.0399 per 100,000 Btu.

State Speaks. The regional market is constantly growing. The forest products industry, especially pulp and paper, plywood, and various kinds of hardboards and particle board, is expanding rapidly and so is its use of chemicals. Three major chemical companies announced plant locations or expansion plans, part of the growth trend. There is abundant low cost power for electroprocess industries from the Columbia River, which pours 183,000,000 acre feet into the ocean annually. Good deep water sites are available for ocean transportation, for importation of raw materials. There is a surplus of technically trained graduates from colleges and universities. Oregon has excellent livability. Climate, schools and other factors make it easy to attract and keep people. The state offers not only easy access to ocean trade, but also to inland markets. The change in emphasis from extractive industries to ever growing diversification offers many opportunities. #

PENNSYLVANIA

Industrial Tax Structure. No state tax on real or tangible personal property; taxpayer permitted to deduct estimated amount of state income tax from net income subject to tax. Communities prohibited from levying property tax on manufacturing machinery, equipment, or inventory. Corporate net income tax 6%. Manufacturing exempt from capital stock tax; domestic and foreign corporations may apportion capital between that used in manufacturing and other kinds of capital subject to 5-mill tax. Equalization Board reports a ratio of assessed valuation to market value of 23.7% for whole state (is effective rate of $8 to $20 per $1000 valuation on real property). Industrial Development Authority financing plan is inducement to build plants.

Transportation. Over 9000 miles of rails in state shared by: Pennsylvania; New York Central; Reading; Baltimore & Ohio; Erie; Lehigh Valley; and Delaware, Lackawanna and Western. Major ocean port is Philadelphia, inland port is Erie on Lake Erie. Allegheny, Monongahela and Ohio rivers lead to the Mississippi.

Raw Materials. State leads in production of anthracite and coke, is second in bituminous coal and petroleum products, and tenth in natural gas. Other chemical raw materials include limestone, silica sand, clays, and salt.

Water Supply. Supply of industrial water not a problem in any major industrial area. Industrial wastes must be treated before discharge into any stream, degree of treatment required comparable to that required for domestic sewage, discharge of certain toxic materials not permitted, clean stream regulations designed to insure continuing supplies of good quality water for industry.

Power and Fuel. Prevailing energy charge for large industrial users ranges from 0.65 to 0.75¢ per kwhr. Other charges depend on character of service. Average net rate for large power users as low as 0.72¢ per kwhr. Fuel rate depends on location in state. A number of power generating stations located at mines.

State Speaks. Pennsylvania's chemical industry is a finishing rather than basic producing type and coke has been a major source of chemical intermediates. Up to a half of all light aromatics produced in coke ovens come from the state. Pittsburgh, and the industrialized areas along the navigable rivers named above, have been growing steadily in chemical plants dependent on coal chemicals and barge navigation. Opportunities are ripe for chemical plant expansions, particularly for secondary chemical products. St. Lawrence Seaway and large fresh water supply of Lake Erie are conducive to chemical plant development. Anthracite fields offer opportunities for certain types of chemical plants. Facilities, technical skill, and experienced workers in steel mills and metal-working plants are a major source of chemical plant construction design and equipment. Recent innovations in chemical production and use have been adapted by the steel plants; refineries of coal tar chemicals and oxygen plants to increase furnace capacities have been newly installed.

RHODE ISLAND

Industrial Tax Structure. Domestic Rhode Island corporations subject to one of three alternate taxes (whichever yields highest amount): net income—at 6% based on weighted ratios of income, wages, or real property within the state to that outside; corporate excess—$4 per $1,000; or corporation franchise—at $2.50 per $10,000 of authorized capital stock. Unincorporated business taxed on gross receipts at $2 per $1,000 on retail or $1 per $1,000 on wholesale. Sales or use tax, 3% on purchase of durable machinery and equipment. All employers pay state unemployment compensation of 2.7% on first $3,600 of individual employee's annual earnings. Business also subject to local taxes ranging from $16.45 to $48 per $1,000 valuation. Some outlying towns also assess nominal fire district taxes. Some communities concede stabilized tax rates and abatements. Legislation permits tax abatements up to 10 years. No state personal income tax.

Transportation. Excellent highways and transportation system permit shipments overnight as far as Philadelphia. New York, New Haven & Hartford railroad has 370 miles of track in Rhode Island. Port of Providence has facilities accessible to ocean-going vessels. Seven major airlines have terminals at two state-owned airports.

Raw Materials. State does not have basic chemical raw materials but is stressing chemical by-product industry as logically suitable for Rhode Island economy.

Water Supply. Water is plentiful and free from impurities. No unusual aspects in air and stream waste disposal laws; disposal of waste in inland streams prohibited without treatment.

Power and Fuel. Representative electric power costs range downward from 2.6613 to 1.4376¢ per kwhr for Narragansett Electric Co., and 2.488 to 1.136¢ per kwhr for Blackstone Valley Gas & Electric Co. for consumption of 22½-thousand to 2½-million kwhr per month, respectively. Former includes fuel adjustment factor of 0.378¢ per kwhr, latter includes fuel clause credit of 1.1 mills per kwhr plus 95% power factor. Fuel gas normally rated at 1050 Btu per cu. ft. Sample industrial charge after first 100 cu. ft. at $1.50 flat rate, ranges from 33¢ per 100 cu. ft. down to 11½¢ per 100 cu. ft. for over 200,000 cu. ft. Bills rendered on gross basis with 6% discount if paid within 15 days of billing.

State Speaks. An important role is played in the industrial revitalization of the state by the Rhode Island Industrial Building Authority which guarantees industrial mortgage commitments and cites the leasing, rather than owning, of plants as a tax advantage. To offset state's lack of basic chemical raw materials, the R. I. Development Council sponsors a program of industrial development on a selective basis emphasizing chemical by-product industry. Ample labor supply of intelligent workers. About 35% of state's labor force employed in manufacturing, compared with 24% for nation as a whole; employment now concentrated in textiles, metal trades, jewelry, and rubber. Nine colleges and universities in the state. University of R. I. willing to cooperate on industry-sponsored research projects.

SOUTH CAROLINA

Industrial Tax Structure. No state property tax, levied only at local level, but industrial assessment rates set by state. As industrial inducement, most counties exempt industry for five years except for school taxes. Domestic corporations subject to organization and qualification fee: 1 mill per $1 of capital on first $100,000, ½ mill per $1 up to $1 million, ¼ mill per $1 over $1 million; foreign companies pay $50 declaration fee. Domestic corporation income tax 5% on net income before Federal taxes; foreign companies allowed one of three alternative taxes: two-factor or three-factor formula based on ratios of property, payroll, and sales; or "separate-bookkeeping" formula. Domestic and foreign companies both pay annual license fee of 1 mill on a proportion of total amount paid in as capital stock, and amount paid in as surplus. Individuals pay personal income tax.

Transportation. Over 3500 miles of rail lines: Southern Railway—1216; Atlantic Coast Line—1243; Seaboard Air Line—732; rest are local lines. Major ports providing facilities to ocean-going vessels and access to Inland Waterway are Charleston, Beaufort, and Georgetown.

Raw Materials. Chemical resources include limestone, clay, silica, sericite, zircon, bentonite, Fuller's earth, titanium concentrates, monazite and rare earths, vermiculite, kyanite, mullite, pyrite, barite, sillimanite, alumina, glauconite, and naval stores.

Water Supply. Adequate industrial water exists in all areas of the state. There are no unusual restrictions on stream pollution.

Power and Fuel. Prevailing industrial power rate for electricity is 6.354 mills per kwhr at 100% load factor. Rate varies with demand and use; example is: $369 for 15,000 kwhr at 75 kw demand, to $4,293 for 400,000 kwhr at 1000 kw demand. Natural gas rated 40¢ per million Btu; No. 6 fuel oil—48.8¢ No. 5—56.3¢, No. 2—81.4¢ per million Btu; coal (based on 13,700 industrial fine coal) at 28.18¢ per million Btu.

State Speaks. A combination of facilities creates a favorable economic package for locating a chemical plant in South Carolina. Constitutional mandate requires state to operate on a balanced budget, thus a sound tax structure invites and encourages industrial development. Ample transportation provides access to vast, new textile market—about ⅓ country's silk goods and synthetic fibers are produced in the state. State Development Board aids in selecting processing sites, and furnishes complete data on labor supply, transportation, power, water supply, building, and other information needed by prospective manufacturers. State research programs and facilities are available for manufacturer's use. There are abundant natural resources including forests, minerals, and water. Two rivers in the state rank second and third on the Atlantic coast in drainage area. State has a mild climate and ample year-round rainfall; ample, young labor supply, and year-round recreational facilities to attract and keep desirable technical personnel. #

SOUTH DAKOTA

Industrial Tax Structure. General property tax based on 60% of assessed value of real and personal property; rate fixed locally, varies from place to place. Severance tax of 2½% on mineral products mined based on value at time of production, goes up to 4% if base price increases 25% above price on July 1, 1957. First 100,000 tons exempt. Special Provisions: no corporation or personal income tax in South Dakota.

Transportation. Leading railroads: Chicago, Milwaukee, St. Paul & Pacific—1,682 miles; Chicago and Northwestern—1,334 miles; Great Northern—276 miles. No port or inland waterway facilities.

Raw Materials. Petroleum—small production in northwest part of state. Lignite—small commercial production, large estimated reserves. Manganese—vast reserves of low-grade ore requiring beneficiation. Lithium ores—modest proved reserves in Black Hills area. Also proved reserves of beryl, columbite, tantalite.

Water Supply. Best water supplies along Missouri River, in central part of state from artesian aquifers, and in southeastern part of state from shallow aquifers. Problem areas in northwestern and north central part of state west of Missouri River. No unusual air and stream waste disposal laws.

Power and Fuel. Industrial power rates: Eastern area of state (over 1,000,000 kwhr/month)—70¢/kwhr; Western area of state (over 40,000 kwhr/month)—90¢/kwhr; Central area of state (over 10,000 kwhr/month)—$1.00/kwhr. Fuel rate is 25¢ to 40¢/million Btu, depending on fuel and location.

State Speaks. Although South Dakota has no significant chemical industry at this time, general conditions favorable to certain types of chemical production are rapidly improving. Construction of four dams across the Missouri River will improve industrial water supplies both quantitatively and qualitatively, as well as increasing generation of electric power within the state. Increased availability of natural gas in eastern South Dakota and its continued availability in the Black Hills area has improved the fuel picture. Large quantities of lignite continue to be available in the state at relatively low cost for use either as a fuel or as a chemical raw material. Manufacture of agriculture-oriented chemicals would seem to have the most imminent possibility of success in South Dakota, since the overall economy of the state is dominated by agriculture. Such projects as the production of fertilizers, insecticides, and herbicides would seem to merit study, especially if increase in irrigation in future years brings about more intensive cultivation. Labor is intelligent and hard-working; the state has generally had a minimum of labor difficulties; there is a Right-to-Work law on the books. #

TENNESSEE

Industrial Tax Structure. Franchise tax on foreign and domestic corporations. Rate is 15¢ per $100 based on outstanding stock, surplus and undivided profits apportioned to the state. Corporate income or excise tax of 3.75% on net earnings of corporations, foreign and domestic. No personal income tax, except on income from stocks and bonds. Tax applies to individuals, partnerships, and trusts. Sales and use tax at 3% on retail sales, and on cost price of each item or article used, consumed, or stored for use of consumption in Tennessee. Special provisions: the 3% sales and use tax is reduced to 1% on "machinery used directly in the manufacturing process, incorporated for the first time in plant facilities in Tennessee and which does not replace machinery in such plants."

Transportation. Major rail lines are: Louisville & Nashville—1,712 miles; Southern Railway System—779 miles; Illinois Central—303 miles; Tennessee Central—269 miles; Gulf-Mobile & Ohio—214 miles. No ocean ports. Major terminals on Cumberland River are Nashville and Old Hickory. Tennessee River ports are Chattanooga and Knoxville, Mississippi port is Memphis.

Raw Materials. Copper, zinc, phosphate, coal, limestone, pottery clays, barite, manganese, iron. Vast hardwood and softwood timber resources.

Water Supply. Abundant from surface or underground sources. Large-volume users can be accommodated along the Cumberland, Tennessee, and Mississippi Rivers.

Power and Fuel. Large supply of low-cost power, chiefly from TVA system, generally 30-45% below national average. Industrial power costs about 6.03 mills per kwhr on monthly consumption of 400,000 kwhr with 1,000 kw demand. Coal, natural gas, fuel oil economically available. Coal as low as $5.50 per delivered ton. Natural gas rates as low as 17¢ per 1,000 cu. ft. available.

State Speaks. Tennessee is centrally located for distribution to the major market centers of the East and the Middle West, and to the rapidly expanding markets of the South and Southwest. Overnight freight service to St. Louis, Cincinnati, Chicago, New Orleans, Atlanta, Baltimore. In addition to the 14 railroad systems, the state is served by 782 certificated motor freight carriers and 10 commercial airlines. Wage rates are comparable to the general average in the South. Unskilled labor averages around a dollar an hour, though rates vary throughout the state. Plant construction costs are reasonable. A modern manufacturing plant can be built in Tennessee for approximately $3.75 per square foot without air-conditioning, and as low as $5.50 a square foot with air conditioning throughout. #

TEXAS

Industrial Tax Structure. There are no state or local taxes on corporate income, and no general sales tax in Texas. Foreign corporations doing business in Texas pay fees and taxes on the same basis as domestic corporations. The only taxes applied generally to all types of business firms are ad valorem taxes, corporate fees and annual franchise taxes. Some businesses, particularly those dealing with production of natural resources, pay a gross receipts or severance tax. State has a stock transfer tax of 3.3¢/$100 par value and 3.3¢/share on no par value stock. Unemployment compensation laws similar to other states (2.7% of gross payroll based on max. $3000 per employee).

Transportation. Major railroads are: Burlington (1426 miles of total tracks); Missouri, Kansas and Texas (1784 miles); Missouri Pacific (3357 miles); Texas and Pacific (1764 miles); Santa Fe (5107 miles); and Southern Pacific (4973 miles). Major ports with access to ocean-going vessels are Orange, Port Arthur, Beaumont, Houston, Galveston, Texas City, Freeport, Corpus Christi, Brownsville, and Port Isabel.

Raw Materials. The state is first in production of petroleum, natural gas, and sulfur. Texas is among leaders in production of cement, clay, lime, stone, sand and gravel, and salts.

Water Supply. The water picture within Texas is highly diversified as a result of great variations in physiography features and extreme climatic variations. Central and western part of state is generally deficient in water.

Power and Fuel. Approximate net costs per kwhr at 100% monthly load factor, 12 kv service with no fuel adjustment, are 0.53¢ for 25,000 KVA, 0.58¢ for 100 KVA, 0.74¢ for 250 KVA and 0.91¢ for 100 KVA. For 69 kv service, the costs per kwhr for 100% load factor, no fuel adjustment, are 0.52¢ for 25,000 KVA, 0.57¢ for 1000 KVA and 0.9¢ per 100 KVA. The approx. fuel rate for natural gas is 20¢ per million Btu.

State Speaks. Texas has much to offer the chemical industry. The natural gas reserves, 46% of the U. S. total, and the crude oil reserves, 47% of the U. S. total, provide cheap, clean fuels for industrial consumption. In addition, these fuels are the principal raw materials of the petrochemical industry. Sulfur, salt, lime, and gypsum provide raw materials for many chemical plants in the state. The forest reserves and cotton provide dependable supplies for the cellulose industry. The state offers many advantages in transportation with a fine network of highways, railroads, barge and ocean service. Another asset for the state is the supply of well skilled, highly productive labor available for the chemical industry. Most of the chemical industry is located along the Gulf Coast where all the advantages of the state are available. Located here are a spectacular array of major chemical plants which include companies of national and international importance. #

UTAH

Industrial Tax Structure. Property tax in Salt Lake City is 78.80 mills with assessment based on 20% of retail. A personal property and inventory tax at same mill levy as above is based on an assessment of 26% of cost. Income tax graduated from 1% of first thousand net to 5% on $5000 net and 5% over. Corporation franchise tax is 4% of net income. Unemployment compensation tax is 2.7% of payroll with a reduced rate after three years (minimum of 0.9%). State has 2% sales tax with additional ½% in Salt Lake County. Motor fuel tax is 5 cents per gallon.

Transportation. Leading railroads serving state are: Union Pacific; Western Pacific; Southern Pacific; Denver, Rio Grande and Western. State has no direct water access for ocean-going vessels.

Raw Materials. State ranks 8th in petroleum, has unlimited salt from brine of Great Salt Lake. Other basic raw materials include natural gas, coal, steel, copper, potash, limestone and dolomite, phosphates, lead, zinc, silver, cobalt, sulfur, uranium, vanadium, and gilsonite. Total of 216 minerals of commercial value.

Water Supply. In majority of state, with the exception of Salt Lake Valley, industrial water may be a problem. State has a stringent stream waste disposal law.

Power and Fuel. Typical monthly industrial electric bills for 75 kw demand are $312 for 15,000 kwhr and $425 for 30,000 kwhr. For 300 kw monthly demand, the bills are $1065 for 60,000 kwhr and $1443 for 120,000 kwhr. The costs for 1000 kw demand are $3357 for 200,000 kwhr and $4617 for 400,000 kwhr. Natural gas ranges around average of 30 cents per 1000 cu. ft. to 23 cents per 1000 cu. ft. for larger industrial users. Coal and fuel oil available in unlimited quantities.

State Speaks. Utah, with adequate power and 216 minerals of commercial value produced within its boundaries, is an ideal location for various chemical plants. In fact, the Salt Lake area is a major center of Western industrial activity. The brines of Great Salt Lake offer a potential to the chemical industry with electrolytic processes yielding over 21 different chemicals. The coal tar products and petrochemicals of this area have not been fully developed. Gilsonite is obtained in Utah, also large reserves of oil and natural gas are being developed. The carnotite and autunite deposits are the greatest proven sources of uranium in the U.S., thus the state has a large uranium processing industry. Also available is copper, with the Kennecott Copper mine producing approximately 30% of the nation's total. At present, the major chemical plants are those engaged in production of fertilizer components. Utah, with its raw material paradise, is truly the industrial hub of the mountain states. #

VERMONT

Industrial Tax Structure. The state of Vermont has attempted to establish a healthy tax climate for attracting new industry. The state has authorized both a Vermont Development Credit Corporation and local credit corporations to encourage industry to enter the state. The bonds of these corporations are exempt from state income taxes. The state has also issued municipal bonds for industrial development, and has exempted local real property taxes for new industries. Local revenue bonds for construction of industrial buildings are also authorized. A special plan for attracting industry permits the communities to stabilize a total Dollar Tax Bill for a period of up to 10 years. The average tax rate in the state is $6.40 per hundred based on an average assessment of 30%.

Transportation. State has 817 miles of trackage. Major rail carriers are Boston and Maine; Canadian National; Canadian Pacific; Central Vermont; Delaware and Hudson; Maine Central; and Rutland. No ports at present. Champlain canal resulting from the development of the St. Lawrence Seaway will permit ocean-going ships to enter Lake Champlain and have access to Vermont. Primary airlines are Eastern and Northeast.

Raw Materials. State produces 95% of nation's asbestos and has large deposits of talc, granite, and marble. Other minerals such as potash, lime, slate, mica, chlorite, iron, copper, manganese, lignite, clay, are also available.

Water Supply. There are no areas in the state where a supply of industrial water would be a problem.

Power and Fuels. Typical industrial electric bills for 75 kw billing demand are $283 for 15,000 kwhr and $410 for 30,000 kwhr. For 300 kw the costs are $1067 for 60,000 kwhr and $1579 for 120,000 kwhr. For 1000 kw the costs are $3508 for 200,000 kwhr and $5215 for 400,000 kwhr.

State Speaks. In the ensuing years, Vermont, according to its own estimate, will become a strategic location for chemical processing plants. The reasons are many and varied, but the most obvious is that the development of the St. Lawrence Seaway, the largest inland navigation system on the continent, and the resulting Champlain cutoff, will bring ocean-going depth into Lake Champlain. Access to New York, the Atlantic, and the Great Lakes will make Vermont a very favorable location. In addition, the Canadian complex immediately to the north is a fantastically expanding market. Thus, Vermont is rapidly finding itself in the middle of two expanding metropolitan areas. In addition, the recent rate reductions for electric power from importation of St. Lawrence Seaway power will also make this state more attractive to industry. The tax climate in Vermont offers another advantage to industries which locate within the state. #

VIRGINIA

Industrial Tax Structure. State has a corporate income tax of 5% and a capital (inventory) tax of 75¢ per $100 (reduced to 65¢ effective 1963). Real property is taxed locally only, with county average assessment ratio of 22%, and county average true tax rate of 65%. There are also miscellaneous registration and charter fees. The state does not offer tax concessions. The 1960 General Assembly of Virginia enacted legislation providing a new formula for the apportionment and allocation of income of corporations operating both within and without the state. This new formula becomes effective January 1, 1962, and will increase Virginia's competitive position for attracting multistate firms.

Transportation. Main ports are Hampton Roads (Newport News, Norfolk, Portsmouth, South Norfolk) and River Ports (Alexandria, Hopewell, Richmond). Nearly 300 piers, 10 million sq. ft. of warehouse and transit sheds. Serviced by over 100 steamship lines connecting 286 world ports, and nine trunk line railroads operating in 21 states. Modern mechanized port facilities for handling cargoes of all kinds. Total trackage is 6907 miles, major railroads are Chesapeake & Ohio; Norfolk & Western; Southern; and Virginian.

Raw Materials. Bituminous coal accounts for two-thirds annual mineral production, limestone and related resources (dolomite, marl, marble) rank next. Natural gas has become a major energy factor.

Water Supply. Number of excellent sites with adequate surface water to accommodate chemical plants. State Water Control Law established to safeguard waters from pollution.

Power and Fuel. Typical industrial electric bill for billing demand of 75 kw (monthly consumption 15,000 kwhr) is $369, for 300 kw (60,000 kwhr) the cost is $1144, and for 1000 kw (400,000 kwhr) the cost is about $5000.

State Speaks. The chemical industry, dating back to 1607, has become one of the fastest growing activities in Virginia within the past 25 years. The principal segment of the chemical industry is the organic group (65% of 33,100 employed in chemical industry) particularly synthetic fibers manfactured by Allied Chemical, American Viscose, Celanese, Dow, Du Pont, and Industrial Rayon. The industrial inorganic group is second, the fertilizer group is third, drugs and medicines are also well-represented. The availability and close proximity of markets, large quantities of surface water, and splendid productive labor are among the many factors which have brought about the growth and are favorable to the continued expansion of the chemical industry in Virginia. Also instrumental in this development, growth, and expansion is the availability of excellent sites and access to raw materials.

WASHINGTON

Industrial Tax Structure. No corporate income tax, no personal income tax or intangible property tax. Property tax on all real and all tangible personal property; maximum level of assessed valuation set at 50%, prevailing level in practice is nearer 20%. Constitutional limitation on property taxes provides that aggregate of all tax levy on real and personal property by the state, municipal corporations, taxing districts, and government agencies, shall not in any year exceed 40 mills on the dollar. In 1957, Washington property taxes amounted to $47.26 per capita, compared to U.S. average of $72.65. Retail sales and use tax now at 4%, termination set at July 1, 1961. No special provisions or exemptions.

Transportation. Main railroad lines are: Great Northern; Union Pacific; Northern Pacific; Chicago, Milwaukee, St. Paul & Pacific; Spokane, Portland & Seattle. Total mileage in Washington—5,955 miles. Main ports for ocean-going shipping are: Tacoma, Olympia, Seattle, Everett, Anacortes, Bellingham, Bremerton, Port Townsend, Port Angeles, Raymond, South Bend, Aberdeen, Hoquiam, Longview, Kalama, Vancouver, Washougal-Camas. Access to inland waterways is provided by the ports of Pasco, Kennewick, Walla Walla, Longview, Kalama, Vancouver, Washougal-Camas.

Raw Materials. Limestone and lime, sodium carbonate, sodium sulfate, petroleum by-products, coal, sulfur, gypsum, dolomite, magnesite (1st nationally), industrial alcohols (from pulp mill wastes, 1st nationally), forest products (1st nationally).

Water Supply. Washington is first state nationally in supply of cold, fresh water. No unusual waste disposal laws.

Power and Fuel. Washington also first nationally in supply of low-cost electricity. Cost varies from 6.8 mills per kwhr up to 200 hp demand, graduated down to 4 mills for demands from 3,000 hp and over. Approximate natural gas rate is 36-38¢ per 1000 cu. ft., 45-50¢ for non-interruptible service.

State Speaks. Industrial sites are available in Washington adjacent to deep water, railroad, and major highway transportation. Technical educational needs are being met by many colleges and universites, several of which give degrees in chemical engineering. This is being supplemented by a program to introduce engineering courses into junior colleges. Washington's climate is ideal; there are no severe winters. The entire West Coast market can be efficiently served from Washington, as well as the Alaskan and foreign markets. This strategic geographical location, combined with its natural resources and its abundant supplies of water, cheap electric power, and natural gas make the state a natural choice for location of new chemical manufacturing facilities.

WEST VIRGINIA

Industrial Tax Structure. One basic tax, the Business and Occupation Privilege Tax. Rates vary according to nature of business. On production of natural resources, levy is on value of resources produced at point of production in state. Forty cents on each $100 for manufacturing. Ad valorem: property used in manufacturing, if within a municipality, has maximum rate $2.00 on each $100 of valuation. Outside a municipality, is $150 on each $100. While no special inducements exist, the over-all tax burden is lower than in most states. There is no corporate net income tax, nor personal.

Transportation. Leading railroads are Norfolk & Western—714 miles; Chesapeake & Ohio—1,012; Baltimore & Ohio—1,366; New York Central—152. Port of New Orleans is accessible by rail and water via Ohio and Mississippi Rivers. Direct rail to Norfolk and Baltimore on the Atlantic. Also accessible to the Great Lakes at Toledo, Sandusky, Cleveland and Lorain, Ohio, and Erie, Pa. Ohio, Great Kanawha and Monongahela Rivers have 378 navigable miles.

Raw Material. West Virginia is tops in bituminous coal production in the nation. In salt, it ranks seventh, in petroleum, fourteenth. Other materials are natural gas, salt brines, rock salt and limestone.

Water Supply. There is an unlimited supply of water for industrial purposes, for cooling and processing.

Power and Fuel. Primary service from voltages ranging from 4000 to 138,000. Typical costs: 1000-5,000 KVA demand 7-8½ mills; 5,000-12,000 KVA, 7-7½ mills; over 12,000 KVA, 6-6½ mills. Fuel: Coals vary in heat content from 12,500 to 14,200 Btu, on a received basis. Prices from $3.75 to $5.00 f.o.b. for various grades of boiler steam coal, and from $5.00 to $7.00 a ton f.o.b. for metallurgical coal.

State Speaks. West Virginia's proximity to major eastern markets, its available natural resources, consisting of coal, petroleum, natural gas, salt brine, limestone, timber, water, and its plentiful and cheap electric power, surplus of skilled workers, high productive labor, make it a desirable location for the chemical industry. This is borne out by the fact that other chemical operations have prospered in the state. The navigable river valleys have witnessed a tremendous growth, and the greatest names in the industry have successfully based operations in the state. Along its 378 miles of navigable rivers, the Ohio, Kanawha, Monongahela, and Big Sandy, there are some of the most attractive sites in the Ohio River Basin. These sites range from 100 to 2000 acres of flood free land. Experience has proven that a chemical operation can make a profit in West Virginia. #

WISCONSIN

Industrial Tax Structure. Real property tax rates vary with locality, assessed valuations average 50 to 60% market value. Property tax on stock, machinery, tools, etc. Corporate income tax shared with local governments is effective in lowering property taxes. No general sales tax, use tax, receipts tax, franchise tax, intangibles or stock transfer tax.

Transportation. Major railroads—Chicago & Northwestern; The Milwaukee Road; Green Bay & Western; Burlington Lines; and Illinois Central—share almost 10,000 miles of track in Wisconsin. Port of Milwaukee is served by 40 direct Great Lakes-Overseas shipping carriers using the St. Lawrence Seaway. Also handling Seaway shipping are ports of Green Bay, Kenosha, Sheboygan, and Superior. Fourteen ports handle Great Lakes shipping, and six Mississippi River ports handle barge traffic. Besides the variety of loading facilities at existing docks, most of the ports, above, have available waterfront sites for industrial and commercial development.

Raw Materials. State resources include high calcium lime, high magnesium content dolomite, copper, iron, lead, zinc, silica sand, clay, wood, and lignins and wood sugars in sulfite waste liquor.

Water Supply. Water is generally available in large quantities and in unlimited amounts along Lakes Michigan and Superior. Water problems exist in only isolated instances. No unusual stream pollution laws, nor laws governing air pollution as they affect the public, but several cities have ordinances. Other states have used Wisconsin stream pollution statutes as a model. Law provides exemption from real estate taxes for five years for facilities built for abatement of water or air pollution, also provides rapid tax write-off for tax purposes on same.

Power and Fuel. Energy charge runs about ¾¢ per kwhr for large users. Coal, at about 34¢ per million Btu delivered at user's dock on Lake Michigan; natural gas as low as 4½¢ per therm (10^5 Btu) for interruptible service in unlimited availability. Petroleum residual fuels 8 to 9¢ per gal. at about 1.5 therm per gal.

State Speaks. State has an ample labor supply. Is one of the largest industrial states, providing a large market for chemicals, yet has relatively small chemical industry of its own. Historically, this has been the result of lack of raw materials. This situation is changing with advent of new technology and improvement of availability of materials. Wisconsin will receive large amounts of petrochemical feed-stocks and sulfur via pipeline from Canada. Chemical exploitation of the state's vast forest preserves has hardly begun. Water is available in unlimited quantities in many parts of the state. There is also the further asset by way of technical support from the U.S. Forest Products Laboratory at Michigan State University, and from the Institute of Paper Chemistry at Appleton. #

WYOMING

Industrial Tax Structure. No corporate or individual income tax. State's mainstay is sales and use tax at 2%. State property tax $1.50 per $1,000 assessed valuation. Lands assessed between 20-30% actual value. About 50% total state property taxed ad valorem; oil production taxed 100% posted field prices; industrial property figured on 1938-1939 replacement costs, less 2% per year depreciation on structures, 3% on machinery and equipment. Property tax rate in cities averages $50 per $1,000 assessed valuation; outside cities, $35. Franchise rates on property and assets in state: $5-$50 for values under $1 million, $50 per million or fraction over. Initial filing fees domestic corporations: $25 up to $50,000 capital stock; $50 up to $100,000; and $50 plus 30¢ per $1,000 over $100,000. Foreign corporations: $10 qualification fee plus $1 per $1,000 capital and assets in state. Unemployment tax by employers 0 to 2.7% on individual's first $3,000.

Transportation. Seven rail lines have almost 2,400 miles of track in Wyoming: Union Pacific about half; Chicago, Burlington & Quincy about a quarter; rest divided among five lesser lines.

Raw Materials. State mineral resources bulletin lists 77 major chemical materials, exclusive of derivatives. Trona, uranium, soda ash, sulfates, phosphates, petroleum, coal, iron ore, and sand and gravel among more important items.

Water Supply. Sufficient industrial water in every part of state through one type of acquisition or another. Water is a preferred use under state law; existing water rights may be purchased as needed. Although some areas have industrial water problems, adequate water supply is a main asset of state. To date, ground water underlying whole state not even tapped.

Power and Fuel. Electric power rates vary throughout state, subject to negotiations between company and utility, are often lower than published tariffs. Sample published tariffs: Cheyenne—demand charge $1.25 per month per kw; energy charge 8 mills first 50,000 kwhr per month, 7 mills next 150,000, and 6 mills all additional kwhr per month. Casper—demand charge $1.50 per kw per month first 50 kw, $1.25 each excess kw. Energy charge 1¼¢ per kwhr first 5,000 kw, 1¢ per kwhr next 15,000, 0.8¢ per kw demand next 250 kwhr, and 0.6¢ each additional kwhr, primary delivery and metering discounts, and power factor adjustment. Ample natural gas available throughout state.

State Speaks. Wyoming's chemical raw materials relatively undeveloped and, in some cases, relatively unexplored. Market distance was major deterrent factor, but recent growth of regional markets has encouraged initial development. State is among top five oil and gas producing states; leads in bentonite production; extensive exploration in trona and phosphates. State has no severance tax, no corporate nor personal income tax, produces much more electricity than is being consumed, and has an abundant water supply. The combination of available basic raw materials makes an integrated chemical industry not only possible, but probable in the foreseeable future. #

PUERTO RICO

Industrial Tax Structure. Corporations subject to normal tax of 20 percent on normal tax net income (net of enterprise less 85 percent of total dividends received from corporations established under P. R. laws). Surtax on "surtax net income" (75 percent of total corporation or partnership net). For surtax net over $100,000 rate is $7,500 plus 20% on excess over $100,000. Also subject to additional tax of 5% of dollar amount of combined normal tax and surtax liability. Special provisions: Flexible depreciation schedule, possible to write off up to 100 percent of depreciable assets in any single year. Exemptions available include 10 years on corporate and partnership net income tax; 10 years on personal and corporate partnership net income tax; 7 years on dividends or profits from exempt operations; and 5-10 years on property tax depending on valuation of property which favors large investments. Eligible operations exempt from municipal license taxes for 10 years.

Transportation. Twelve airlines and 29 steamship lines serve the island. Best port, San Juan, capitol, depth 38 ft. at entrance, 30 ft. in manuevering area, ranging from 28-33 ft. at piers. Port has 18 piers-22 berths. Second port is Ponce, entrance depth 29 ft., port depths vary from 22-26 ft. Bulkhead wharf 1,890 ft. long. Third port is Mayaguez, harbor protected by offshore shoals. Entrance has 90 ft. depth. and 30 ft. in anchoring areas.

Raw Materials. Major non-metallic minerals are: Salt, 16,000 short tons produced 1959; Clays, 180,000 short tons produced 1959; and lime. Other chemicals produced: glycols, sulfuric acid, acetylene, oxygen, carbon dioxide and refinery gases.

Water Supply. Water available for industrial purposes. Detailed report being printed by P. R. Aqueduct and Sewer Authority.

Power and Fuel. Where demand exceeds 250 kva energy charge is 11.5 mills per kwhr for the first 300 kwhr per month per kva of maximum demand used. All additional energy at 7.5 mills per kwhr. With demand of 500 kva or over and monthly load factor of 75 percent or more, rates drop to 9 mills per kwhr for first 200 kwhr per month per kva of maximum demand. Excess at 6 mills per kwhr. Fuel adjustment. Above service available anywhere.

The Commonwealth Speaks. In its broad aspects, Puerto Rico offers to bona-fide manufacturers the following advantages: 1. Corporate tax exemption for a period of 10 years (it is not covered by the Federal Income Tax Law). 2. Income tax exemption for 7 years for dividends received by bona-fide residents of Puerto Rico from a tax exempt firm. 3. Exemption from 5-10 years from property taxes. 4. Industrial buildings for rent or sale throughout the Island. 5. The Government Development Bank for Puerto Rico will consider financing up to 50 percent of appraised value of machinery and equipment and/or up to 60 percent of appraised value of real estate if placed as collateral. 6. Training assistance for your work force and supervisory personnel. 7. Special financial, locational incentives for establishing factories in acute unemployment areas. 8. An intelligent and proud ample labor supply. #

FACTS FIGURES AND IDEAS FROM BOWEN ENGINEERING, INC.

Spray drying NEWS

RECOGNIZED LEADER IN SPRAY DRYING SINCE 1926

VOLUME 2, NO. 6

SPEAKING FOR BOWEN

DERWARD McKINNEY
Sales Engineer
discusses a promising new spray drying process

SPRAY COATING

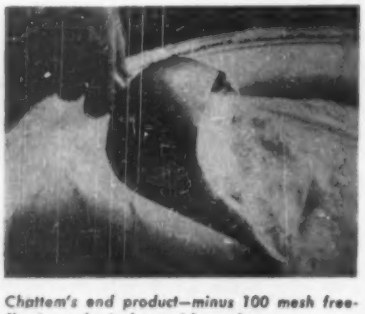
Recently Bowen has been instrumental in developing a new spray drying technique —called SPRAY COATING—in which one substance can be coated with another in a single, instantaneous, one-step process.

With many products, for instance in the pharmaceutical field, it is desirable to cover or hide an objectionable taste or odor or to provide increased shelf life to a sensitive material. Also, it is sometimes advantageous to maintain a predetermined rate of activity or to make a substance totally inactive or active only under certain specified conditions. SPRAY COATING may be the answer if you have a problem similar to these.

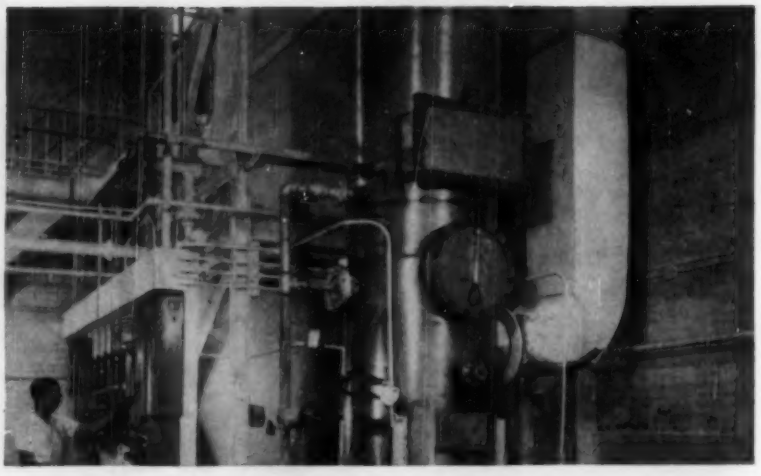
A typical example of SPRAY COATING occurs in vitamin utilization. Vitamins used in poultry and cattle feeds can be coated with an inert material and made totally inactive during periods of shipping and storage and, in fact, until taken internally and the coating dissolved by substances in the stomach where the full potential of the vitamin is realized.

Another example is in the encapsulation of food flavoring oils with an inert material to retain essential, volatile oils in order to provide maximum shelf life with minimum degradation. Ease of less costly dry shipping and maximum availability and ease of use by the food manufacturers are natural by-products. Other applications have included the coating of metal powders so that they react only under certain circumstances; and the coating of pharmaceuticals to provide a delayed or slowed-down reaction.

Bowen will be glad to discuss and assist you with any SPRAY COATING or other drying problem you may have. The Bowen test laboratory is available, along with the extensive experience of our test engineers, to determine whether your particular project is feasible.



Chattem's end product—minus 100 mesh free-flowing spherical antacid powders.



Stainless steel Bowen 7-ft.-diameter spray dryer used for heat-sensitive antacid powders at Chattem Chemicals.

Chattanooga Medicine Increases Production with Spray Dryer

Heat-Sensitive Antacid Ingredient Produced In Spherical, Free-Flowing Particles —100 Mesh

Chattem Chemicals Division of The Chattanooga Medicine Co., faced with burgeoning demand for its patented DASC (dihydroxy aluminum sodium carbonate) found that the addition of more tray dryers was no longer practical for production of the antacid powder.

TRAY DRYERS COSTLY—Not only would the installation of additional tray dryers and accessory equipment be expensive in terms of capital equipment and labor, but Chattem did not have the physical space to accommodate the tray dryers and the trays in its Tennessee plant.

Chattem engineers presented their problem to Bowen. Production had to be increased drastically. Also, because most drug end-products using the antacid (indigestion and cold remedies) are tabletted, DASC had to have characteristics that would allow dry pressing. This meant that spherical particles were highly desirable to assure free-flow and ease of pressing. Without spray drying, this would require a pelleting or granulating step. To complicate the problem still further, particle size had to be under 100 mesh and the particles themselves were subject to some slight decomposition under sustained high temperatures.

TESTS CONFIRM SPRAY DRYER—The problem, although complex, was made to order for spray drying and subsequent tests at the Bowen test laboratory proved that one of the smallest of Bowen's standard spray dryers, the 7-ft. drying chamber (No. 2) model could more than keep up with manufacturing demands while simplifying production and cutting labor and overhead costs as well.

OUTPUT INCREASED DRASTICALLY—Chattem installed the dryer almost five years ago. Immediately, production was increased. Officials have found that the spray dryer can process in eight hours as much antacid powder as three of their double-rack tray dryers will yield in 20 to 24 hours.

Centrifugal atomization is used in the dryer. Gas-heated drying air at 725°F. dries the particles to a predetermined moisture content of 10-12%. Rate of production is 200 pounds an hour or more. Chattem officials acknowledge a "better end product," and they acclaim the "practically trouble-free" operation of the stainless steel spray dryer.

CEP Data Service

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SUBJECT GUIDE to advertised products and services

EQUIPMENT

Analyzers, colorimetric (p. IBC). Complete data from Milton Roy on the "Quantichem" colorimetric analyzer. **Circle 7.**

Anodes, graphite (p. 13). Great Lakes Carbon offers set of Technical Data Sheets with info on properties of graphite anodes. **Circle 11.**

Castings, high-alloy (p. 8). General Catalog from Duraloy has tables for selecting proper alloy for casting specifications. **Circle 112.**

Coatings, plastic, extrusion (p. 167). Complete technical info from Pyramid Plastics. **Circle 120.**

Compressors (p. 126-127). Complete technical details from Cooper-Bessemer. **Circle 62.**

Computer, engineering (p. 71). Complete details on the "Dystac" computer, plus report "Counter Current Multi-Stage Oxidation," from Computer Systems, Inc. **Circle 84.**

Condenser, tower-type (p. 119). Info from Croll-Reynolds on the "Convactor," new design of special condensing tower. **Circle 32.**

Controls, liquid-level (p. 172). Complete technical details from Jo-Bell Products on the "Level-Master." **Circle 110.**

continued on page 118

MATERIALS

Ceramic-Metal Composite Material (p. 6-7). Bulletin 999 from Pfaudler Permutit gives complete technical details on "Nucerite," new ceramic-metal material of construction for processing equipment. **Circle 125.**

Chemicals, organic, synthetic (p. 77). Union Carbide Chemicals offers Booklet "Physical Properties of Synthetic Organic Chemicals" containing properties and applications of nearly 400 different chemicals. **Circle 64-2.**

Coatings, protective, high-temperature (p. 131). Brochure from Midland Industrial Finishes on "Sicon" coatings for temperatures to 1,000° F. **Circle 77.**

Defoamers, silicone (p. 128). Dow Corning offers new "Manual on Foam Control," and info on how to get free samples of its silicone defoamers. **Circle 25.**

Defoamers, silicone (p. 168). Technical data and info on free samples from Dow Corning. **Circle 101.**

Diatomites (p. 157). Info from Johns-Manville on use of "Cellite" diatomites for filtration and mineral filler applications. **Circle 39.**

Ethylene Oxide (p. 159). Bulletin from The Matheson Co., Inc., gives specifications and physical constants. **Circle 117-2.**

continued on page 118

SERVICES

Bearing Lubricating Films (p. 30). General Motors Research Laboratories offers info on its search for "jog-free," stably-distributed, suitably thick oil films required for high-precision bearings. **Circle 14.**

Chemical Plant Site (p. 78). Along lower Susquehanna River. Details from York County Industrial Development Corp., York, Pa. **Circle 94.**

Design and Construction, low-temperature plants (p. 34). Bulletin G-48 "Refrigerated Storage Facilities" from Chicago Bridge & Iron describes facilities for design, fabrication, construction of low-temperature plants. **Circle 15.**

Design and Construction, process plants (p. 138-139). Technical info from Lummus on facilities for design, engineering, construction. **Circle 74.**

Design and Construction, process plants (p. 145). Info from M. W. Kellogg on facilities for design, engineering, and construction in the U. S. and abroad. **Circle 52.**

Fabrication, process equipment (p. IFC). Technical info from Wyatt Metal & Boiler Works Div., Wyatt Industries. **Circle 18.**

Fabrication, process equipment (p. 134). In all weldable materials, including titanium. Bulletin 100, "Titanium Facts," from Nooter Corp. **Circle 41.**

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NOVEMBER 1960

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CEP'S DATA SERVICE—Subject guide to advertised products and services

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 117*

Control Systems, visual (p. 167). Booklet BE-20 from Graphic Systems gives details of the "Boardmaster." **Circle 106.**

Conveyor-elevators, closed-belt (p. 75). Bulletin 349 from Stephens-Adamson Mfg. gives details of the "Zipper" conveyor-elevator. **Circle 5.**

Crushers, special-purpose (p. 173). Bulletin "WC & WS" Crushers, Shredders and Hammermills from American Pulverizer Co. **Circle 30.**

Deionizer (p. 169). Data from Elgin Softener on the new Junior 120 Deionizer, for laboratory, research, industrial use. **Circle 17.**

Detector, voids (p. 129). Technical data and bulletin from Tinker & Rasor on the "Holiday Detector" for finding voids in protective coatings. **Circle 146.**

Dew Point Indicator (p. 160). Complete info from Alnor Instrument, Div. of Illinois Testing Labs, on the "Dewpointer." Bulletin 2051. **Circle 56.**

Dished Covers (p. 164). Full info and specifications in General Catalog from Lenape Hydraulic Pressing & Forging. **Circle 58.**

Dryers, spray (p. 116). Bowen Engineering offers data on heat-sensitive materials drying. **Circle 76-1.**

Dryers, spray (p. 116). Test Laboratory Booklet from Bowen Engineering gives details of its testing facilities in the field of spray drying. **Circle 76-2.**

Dryers, spray (p. 130). Info from Nichols Engineering & Research on the "Nerco-Niro" spray dryer. **Circle 123.**

Dryer, turbine-type (p. 166). Info from Wyssmont on its vertical, continuous "Turbo" dryer. **Circle 129.**

Ejectors, jet (p. 171). Folder from Jet-Vac. **Circle 36.**

Elevators, screw-type (p. 74). Eight basic types, 4 diameters. Details of the "Rotor Lift" from Southwestern Supply and Machine Works. **Circle 28.**

Equipment, processing, graphite (p. 29). Report "Data for Cost Estimation," offered by Falls Industries gives latest designs and costs of many types of impervious graphite processing equipment. **Circle 75.**

Evaporators (p. 21). Bulletin E-100 from Swenson Evaporator gives details of full line. **Circle 68.**

Extruders, plastic pipe (p. 161). Data from Davis-Standard on "Thermatic Series" extruders, with special cooling capacity. **Circle 2.**

Fans, industrial (p. 12). Built to withstand corrosive fumes, abrasive materials, extremes of temperature. Technical info from Garden City Fan & Blower. **Circle 33.**

Filters (p. 135). Data from T. Shriver & Co. on filters and complete filter stations to meet every processing need. **Circle 6.**

Filter, disk, jacketed (p. 170). Allows heating or cooling of product during filtration. Bulletin 19-S from Ertel Engineering. **Circle 82.**

Filters, vacuum (p. 9). Small size, large capacity. Data from Bird Machine on the Bird-Young vacuum filter. **Circle 13.**

Filter Presses (p. 162). Catalog from D. R. Sperry includes details of accessories such as closing devices, plate shifters. **Circle 47.**

Flow Meters, turbine-type (p. 14). Capacities from 0.1 to 40,000 gal./min. Catalog from Potter-Bowser Div., Bowser, Inc., gives complete technical details of the "Pottermeter." **Circle 45.**

Fused Quartz Ware (p. 173). Many standard shapes and sizes, also custom fabrication. Info from Thermal American Fused Quartz. **Circle 149.**

Gaskets, ring, forged (p. 181). Technical info from Southern California Oil Tool Co. **Circle 133.**

Heat Exchangers (p. 69). Details from Heliflow on the Graham "Monobolt" heat exchanger—only one bolt to loosen for disassembly and cleaning. **Circle 79.**

Heat Exchangers (p. 132-133). Patterson-Kelley offers info on new Heat Exchanger Manual, available only on letterhead request. **Circle 50.**

Heat Exchangers (p. 144). Heat Exchanger Bulletin 158-HE offered by Doyle & Roth Manufacturing. **Circle 71.**

Heat Exchangers, air-cooled (p. 28). From simple water coolers to most complicated process coolers and condensers. Data from Smithco Engineering. **Circle 131.**

Heat Exchangers, block-type, graphite (p. 168). Pressures to 200 lb./sq. in., temperatures to 360°F. Bulletin from Kearney Industries, Delanium Graphite Div. **Circle 113.**

Heat Exchangers, panel coil (p. 22). Data Sheet 15-60 Series and Price Bulletin 259 from Dean Products. **Circle 100.**

Heat Exchangers, plate-type (p. 24-25). Booklet from De Laval Separator. **Circle 73-2.**

continued on page 120

MATERIALS *from page 117*

Filter Materials (p. 170). Info from Filpaco Industries on filter paper and filter cloth in many different materials. **Circle 103-1.**

Gases, compressed (p. 159). Catalog from The Matheson Co., Inc., gives prices and data on 82 compressed gases and gas mixtures, gas regulating equipment. **Circle 117-1.**

Heat Transfer Cement (p. 172). Bulletin 300 from Thermon Mfg. describes "Thermon" non-metallic adhesive heat transfer cement. **Circle 23.**

Hydrogen, from ammonia (p. 19-20). Data from U. S. Industrial Chemicals on units for generation of pure hydrogen from ammonia. **Circle 81-3.**

Methionine (p. 19-20). Info from U. S. Industrial Chemicals on use of DL-methionine as dietary supplement. **Circle 81-2.**

Packing, Teflon (p. 167). Catalog FF-1059 from Greene, Tweed gives technical data on "Palmetto" packing. **Circle 34.**

Plasticizer, epoxy (p. 77). Technical Bulletin from Union Carbide Chemicals gives performance data, compatibility, typical analysis of new epoxy plasticizer, Flexol EP-8. **Circle 64-1.**

Polyethylene (p. 19-20). Technical info from U. S. Industrial Chemicals on coating and film grade resins. **Circle 81-1.**

Rubber, synthetic (p. 155). Brochure "Protective Linings and Coatings" from Du Pont gives complete technical info on processing application of "Hypalon" synthetic rubber. **Circle 102.**

Rust Solvent (p. 164). Info from Kano Labs on application of "Aerokroil" rust solvent. **Circle 27.**

SERVICES *from page 117*

Fabrication, process equipment (p. 142). Data from Fuller on pneumatic materials handling systems, rotary compressors and vacuum pumps, feeders, coolers, other types of process equipment. **Circle 19.**

Fabrication, process equipment (p. 148). Bulletin B-500 from Heil Process Equipment lists chemical resistance data and specifications of standard sizes of equipment. **Circle 53.**

Fabrication, process equipment (p. 154). In stainless, aluminum, Monel, nickel, Inconel, all clad materials, nickel-plated steel. Data from Koven Fabricators. **Circle 80.**

continued on page 122

CROLL-REYNOLDS'

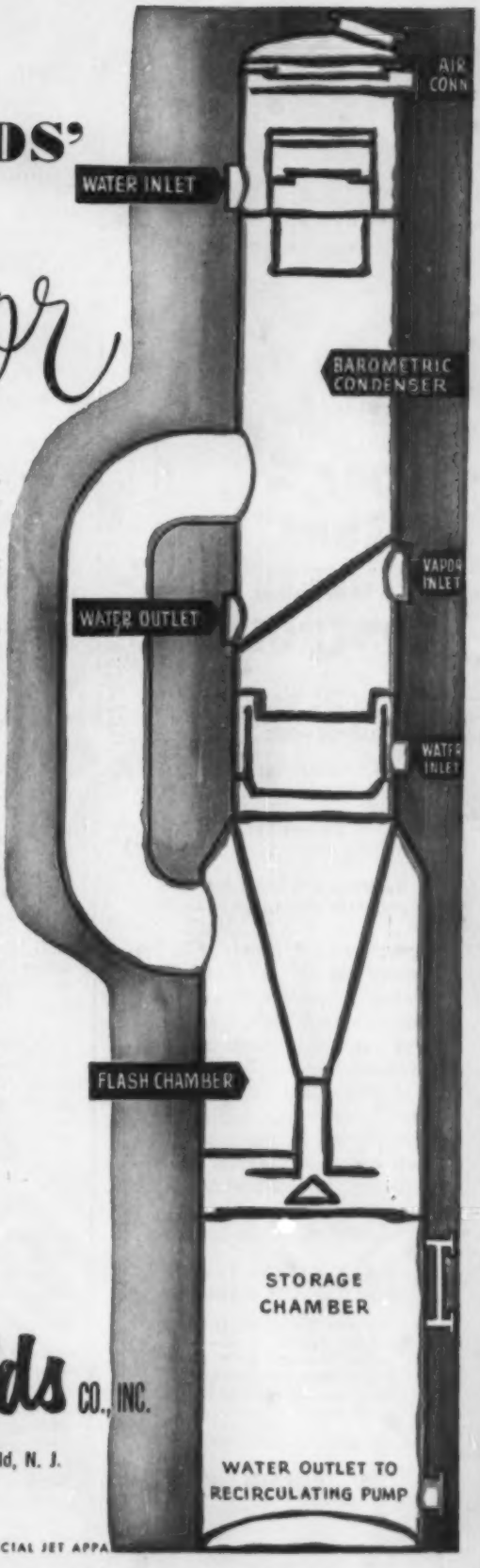
Convactor

If you never heard of a CONVACTOR, do not be surprised. It is an entirely new design of special condensing tower which offers important advantages in some processes.

In the refining of edible oils it recovers fatty acids, most of which were formerly waste. It offers the additional advantage of totally eliminating stream pollution from this source or the expense of cleaning cooling towers which collect such deposits. It has similar application in fatty acid stills, some other types of distillation processes, dryers, and other large vacuum processing units.

The CONVACTOR is a combination of two condensers and a vacuum cooling chamber. One condenser is of conventional barometric design, the other a highly improved condenser working on the jet principle. The latter condenses the vapor from the process and discharges directly into the vacuum cooling compartment where the heat of condensation is immediately removed. The cold water is then recirculated through the same jet condenser. The flashed vapor from the cooling operation is condensed in a conventional barometric condenser using water from a river, cooling tower or other industrial source. Periodic blow-down or continuous bleed-off from the flash chamber permits recovery. Several large industrial installations have been made.

Patent applied for



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CEP'S DATA SERVICE—

Subject guide to advertised products and services

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 118*

Heaters, process (p. 174). Bulletin 920 from International Boiler Works gives all details of the International-LaMont "Aroclor" heaters. **Circle 109.**

Heating Units, induction (p. 171). Catalog from Lepel High Frequency Laboratories on high-frequency induction heating units. **Circle 116.**

Hydrogen Recovery Units (p. 137). Data from American Air Liquide on design and construction of hydrogen recovery units in capacities from 25 to 350 tons/day. **Circle 16.**

Idlers, conveyor (p. 124). Info from Continental Conveyor & Equipment on idlers, pulleys, bearings, take-ups, drives, trippers, feeders, hold-backs. **Circle 21.**

Loading Arms, ball-joint (p. 158). Catalog 215B from Barco Mfg. gives details of standard and custom-designed, loading arm assemblies. **Circle 8.**

Meters (p. 163). For accurate indication of temperature, frequency, flow, level, pressure, weight. Data from Howell Instruments on the Series BH100 Milli-V-Meter. **Circle 107.**

Meter, tank contents (p. 74). Technical info from Uehling Instrument on the "TankoMeter," designed for measurement of tank contents from any distance away. **Circle 46.**

Mills, grinding, ball (p. 136). Bulletin AH-414-40 from Hardinge gives complete details of its "Tricone" mills. **Circle 83.**

Mills, grinding, impact (p. 72). Entoleter Div. of American Mfg., offers free tests, evaluation on your material. Technical info. **Circle 3.**

Mills, grinding, roller (p. 151). Catalog 79E from Combustion Engineering, Raymond Div., gives technical info on complete line. **Circle 99.**

Mixers (p. 32). Engineering Manual K-57 from Baker Perkins gives complete technical details of its line of "Ko-Kneaders." **Circle 67.**

Mixers (p. 150). Technical info from Rapids Machinery on the Marion mixer. **Circle 126.**

Mixers (p. OBC). Technical data from Mixing Equipment Co. on design and fabrication. **Circle 35.**

Mixers, portable (p. 156). Three basic portable models for from 1 to 250 gal. Info from Gabb Special Products on the "Shear-Flow" mixer. **Circle 49.**

Nozzles, spray (p. 122). Catalog 5900 from Binks Manufacturing gives details on nozzle applications, sizes, capacities, spray patterns, metals. Easy-to-use selection data. **Circle 31.**

Nozzles, spray (p. 150). Capacities from ⅛ pint/min. to 4,000 gal./min., in bronze, cast iron, stainless steel. Catalog from Spray Engineering. **Circle 43.**

Nozzles, spray (p. 160). Catalog 24 from Spraying Systems gives details of over 12,000 standard spray nozzles. **Circle 42.**

Nozzles, spray (p. 162). Catalog 1 from Monarch Mfg. Works. **Circle 40.**

Packing, tower (p. 79). Bulletin S-29R from U. S. Stoneware gives detailed performance data on Intalox Saddles. **Circle 65.**

Packing, tower (p. 165). Info from Packed Column Corp. on advantages of "Goodloe" packing. **Circle 60.**

Piping, corrosion-resistant (p. 10-11). Technical info from Resistoflex on process applications of "Fluoroflex-T" piping. **Circle 128.**

Preheaters, air (p. 141). Brochure from Air Preheater Corp. on "The Ljungstrom Air Preheater for Process Equipment." **Circle 95.**

Pulverizers (p. 165). Technical Data from Sturtevant Mill on the process application of the "Micronizer." **Circle 48.**

Pulverizing Equipment (p. 31). Bulletin 571 from Pulverizing Machinery describes the "Mikro" line of dust collectors, pulverizers, atomizers. **Circle 63.**

Pumps, centrifugal (p. 143). New Catalog 130 from Eastern Industries gives details of 50 different models, much other technical data. **Circle 10.**

Pumps, chemical, small (p. 149). Details from Eco Engineering on rotary, gear, centrifugal types, portable pumping units, valves. **Circle 24.**

Pumps, corrosion-resistant (p. 121) Bulletin 203-7 from Lawrence Pumps contains complete summary of acid and chemical pump data. **Circle 12.**

Pumps, metering (p. 23). Technical data from Lapp Insulator on the "Pulsafeeder," automatic metering pump for chemical applications. **Circle 9.**

Pumps, non-priming (p. 147). Efficiencies as high as 80%. Bulletin from LaBour on its Q and SQ type pumps. **Circle 4.**

Recorders, potentiometer (p. 125). Bulletin M from West Instrument gives details of its "Marksman" model. **Circle 61.**

Reflux Splitter, automatic (p. 120). Pyrex and Teflon construction gives excellent corrosion resistance. Bulletin RS-2 from Chem Flow Corp. **Circle 97.**

Rotameters, alarm (p. 166). For signaling abnormal flow rates. Bulletin 18A from Schutte and Koerting. **Circle 59.**

Screens, vibrating (p. 24-25). Technical info from De Laval Separator on its "Syncro-Matic" design. **Circle 73-3.**

Screener, rotary (p. 169). Complete technical info from J. M. Lehmann on the "Vorti-Siv" screener. **Circle 115.**

Separators (p. 150). Descriptive Booklets from Simon-Carter on precision separating, sizing, and grading machines. **Circle 44.**

Separators, centrifugal (p. 24-25). Brochure from De Laval Separator on the new "De Laval PX Self-Opening Separator." **Circle 73-1.**

Separators, entrainment (p. 4). Bulletin 21 from Otto H. York gives complete technical details of the York Demister. **Circle 20.**

Separators, entrainment (p. 12). Latest Design Guides in Bulletin ME-9 from Metal Textile. **Circle 37.**

Sifters, rotary (p. 5). Single or multiple separations, down to 325 mesh. Bulletin 503 from B. F. Gump. **Circle 148.**

Tanks, stainless (p. 170). In all styles for storage and mixing. Data from Filpaco Industries. **Circle 103-2.**

Tanks, rubber-lined (p. 28). Info from Gates Rubber Co. on tanks lined with wide variety of rubber and plastic compounds. **Circle 104.**

Thermocouple Wire (p. 174). Bulletin 1200-3 from Claud S. Gordon has complete specifications and data. **Circle 105.**

Tubing, technical (p. 26). Info from L. Frank Markel & Sons on "Flexite" tubings, in Teflon, silicone rubber, vinyl, polyethylene, rigid vinyl. **Circle 38.**

Vacuum Producer (p. 27). New Bulletin 5H-HS gives complete detaills on application, construction, operation of packaged "Hydro-Steam" unit. Schutte and Koerting. **Circle 132.**

Valves, ball-plug (p. 18). In wide range of sizes and ratings. Catalog V-60 from Hydril gives complete details. **Circle 108.**

Valves, reducing, steam (p. 166). Bulletin D-92B from Fisher Governor gives details of Model 92B, built of high-strength nodular iron for pressures to 300 lb./sq. in. **Circle 54.**

continued on page 123

SERVICES *from page 118*

Plant Buildings (p. 112). Info from Maine Department of Economic Development on two industrial buildings available for lease or lease-purchase in Waterville and Portland, Maine. **Circle 57.**

Plant Sites (p. 81). Info from Cushman & Wakefield, broker and appraiser of industrial sites. **Circle 111.**

Plant Sites (p. 84). Info on three available sites at Siloam, Kentucky. Chesapeake and Ohio Railroad. **Circle 51.**

Plant Site Information (p. 80). Info from Greater Burlington Industrial Corp., Burlington, Vermont. **Circle 55.**

Plant Site Information (p. 78). Info from Western Massachusetts Electric Co. on building locations in Easthampton Industrial Park. **Circle 127.**

Plant Site Information (p. 80). Data from Chamber of Commerce, Oneonta, N. Y. on available plant site, including existing private airport. **Circle 98.**

Plant Site Information (p. 80). Info from Industrial Committee, Parsippany, N. J. Brochure. **Circle 130.**

Plant Site Information (p. 115). Info from Florida Power Corp. on Port St. Joe, Florida, as site for chemical facilities. **Circle 66.**

Plant Site Information (p. 82). Comprehensive report from Public Utility District of Grant County, Washington. **Circle 122.**

Plant Site Information (p. 82). Data from Chamber of Commerce, Stockton, Calif., on industrial advantages of chemical plant location in the area. **Circle 150.**

Plant Site Information (p. 82). Info from Fairviews Development Co., Missoula, Montana, on advantages of the area for chemical plant location. **Circle 147.**

Plant Site Information (p. 83). Massachusetts Port Authority offers info on advantages of the Port of Boston area for location of chemical processing plants. **Circle 70.**

Plant Site Information (p. 111). The Galveston, Texas, Chamber of Commerce offers complete data on location of chemical facilities at Galveston. **Circle 78.**

Plant Site Information (p. 113). Public Service Electric and Gas offers Brochure "The New Jersey Story," **Circle 121.**

Plant Site Information (p. 112). Data from Mississippi Power & Light Co. on plant site advantages in Western Mississippi. **Circle 29.**

SUBJECT GUIDE to free technical literature

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT

301 Actuator, pneumatic. Data Sheet from Conoflow Corp. describes complete line of Series 50 cylinder actuators.

302 Analyzer, oxygen. Data from Thermco Instrument Corp. describes an electrolytic-type trace oxygen analyzer.

303 Blowers, positive displacement. A 12-page Brochure from Sutorbilt Corp. describes features of its positive displacement blowers.

304 Compressors. Brochures from The Cooper-Bessemer Corp. describe the company's 200-1000 hp, 400-1500 hp, 4000 hp, 10,000 hp compressors.

305 Compressors, air. Detailed info in Bulletin 203 describes new line of 100 lb. air compressors in the 25-100 hp range from Clark Bros. Co.

306 Computer, analog. Brochures from Electronic Associates, Inc. present info on the Pace TR-10, 221R, and 231R analog computers.

307 Computer, digital. A Bulletin from Bendix Corp. describes versatility of G-15 digital computer in two plants of a refinery.

continued on page 124

MATERIALS

357 Fluorescent Compounds. New 19-page Bulletin from American Instruments Co., Inc. is available as a guide to identifying solutions through fluorescent properties.

358 Gases, compressed. Bulletin from The Matheson Co., Inc. discusses sulfur tetrafluoride, vinyl fluoride, allene available in various cylinder sizes.

359 Glass, properties. A 16-page Booklet from Corning Glass Works presents properties of 32 commercial glasses.

360 Insulating Fill. A 4-page Brochure from Johns-Manville describes Perlox, a low-cost, low-density insulating fill.

361 Insulating Materials. A comparison Chart of properties of insulating materials offered by The Mycalex Corp. of America.

362 Latexes. Twelve-page Brochure from The Dow Chemical Co. lists latexes, their properties, and areas of use.

363 Materials. A 12-page Brochure from The Carborundum Co. presents resume of new products listed in past 2½ years.

continued on page 125

Plant Site Information (p. 114). Info from Bessemer and Lake Erie Railroad on sites in Greenville, Pa. **Circle 85.**

Plant Site Information (p. 82). Brochure from Lewis Terminals, Inc. on industrial advantages of West Palm Beach, Florida. **Circle 114.**

Plant Site Information (p. 114). Data from United Illuminating Co. on the Connecticut Shoreline as a site for chemical manufacturing facilities. **Circle 22.**

Technical Books (p. 181). Catalog from Lefax Publishers has 2,000 listings. **Circle 1.**

Transportation, water (p. 146). Complete info on all kinds of marine transport, from National Marine Service. **Circle 118.**

EQUIPMENT *from page 121*

Vibrator, bin contents (p. 166). Keeps bulk materials moving. Data from Bin-Dicator Co. on the "Bin-Flow" unit. **Circle 26.**

Viscometer (p. 140). For continuous process control. Info from Brookfield Engineering laboratories on the "Viscometran." **Circle 96.**

Wire Cloth (p. 123). In stainless, Monel, Nichrome, phosphor bronze, aluminum, brass, copper. Bulletin F-C from Newark Wire Cloth. **Circle 119.**

SERVICES

370 Computer Service. A 12-page Booklet describes computer service for piping flexibility analysis by The Service Bureau Corp.

371 Conversion Factors. A pocket-size Table from The Ohmart Corp. contains conversion factors for easy reference.

373 Cost Engineering. Booklet from Western Supply Co. discusses modern cost engineering of heat exchangers.

374 Diffuson Coating. Bulletin from Haynes Stellite Co. discusses coating of metals for oxidation resistant use to 2300°F.

376 Phthalic Process. A 4-page Brochure from Badger Mfg. Co. discusses a fluid bed phthalic process.

377 Pipe Fitters Manual. A 72-page handbook containing information for pipe fitters and welders is available from Tube Turns Div. of Chemetron Corp.

380 Standard, clad tube sheet. Copy of proposed copper and copper alloy clad steel plate standard offered by Bridgeport Brass Co.

CEP'S DATA SERVICE—

Subject guide to free technical literature

CIRCLE CORRESPONDING NUMBERS ON DATA SERVICE CARD

EQUIPMENT *from page 122*

308 Control Boards. A 24-page Booklet from Graphic Systems illustrates graphic visual control systems.

309 Controllers, pneumatic. Bulletin J-C describes pressure and temperature controllers from OPW-Jordan Corp.

310 Controls, material handling. Bulletin describes controls for bulk handling of dry materials from Flo-Tronics, Inc.

311 Desuperheater. Bulletin 6D from Schutte and Koerting Co. describes steam ejector atomizing-type desuperheaters.

312 Detector, underground pipe. Information on the Pearson-type detector for buried pipe inspection from Tinker & Rasor.

314 Equipment, dust control. New composite product Bulletin describes complete line of dust control equipment from American Air Filter Co., Inc.

315 Equipment, mill. Bulletin 183-A from Sprout, Waldron & Co., Inc. contains mill equipment for the pulp and paper industry.

316 Equipment, process. Bulletin 27 from York Process Equipment Corp. describes engineered process equipment such as extractors, distillation and gas absorption equipment, demisters, and separator vessels.

317 Fans, industrial. Brochure from Garden City Fan & Blower Co. describes line of fans for ventilating and exhaust systems, materials conveying systems, and service to 2000°F.

318 Feeders, dry chemical. Catalogs DF-78 and 60 from The Permutit Co. describes volumetric feeders used in water and industrial waste process applications.

319 Feeder, gravimetric. Bulletin from B-I-F Industries describes operation of the Omega belt gravimetric feeder.

320 Filters. Bulletin EP-100 from Industrial Filter & Pump Mfg. Co. describes filter operation and construction.

321 Filters, compressed air. Catalog 6000 presents details for compressed air filter from King Eng. Corp.

322 Filters, pressure. Bulletin 150 from T. Shriver & Co., Inc. describes vertical leaf pressure filters for clarifying solutions and recovering solids.

323 Fittings and Flanges. An 8-page Booklet from The Babcock & Wilcox Co. contains data on seamless welding fittings and flanges.

325 Gauges. New 8-page Catalog 520 describes complete line of dial indicating receiver gauges offered by U. S. Gauge, Div. of American Machine & Metals, Inc.

327 Generator, steam. A 16-page Bulletin describes steam or hot water generators from Ames Iron Works, Inc.

328 Heater, cord-type. Complete information on Cal-Cord, a new high temperature wrap-around heater, is available from Glas-Col Apparatus Co.

329 Heat Exchangers. Bulletin 111 from Brown Fintube Co. describes multitube, double pipe heat exchangers.

330 Hinged Closures. Bulletin from Tube Turns Div. of Chemetron Corp. presents new features and extended size ranges for hinged closures.

333 Laboratory Apparatus. A 316-page Catalog from Corning Glass Works gives product information on 9000 items.

334 Mills, attrition. An 8-page Catalog from The Young Machinery Co., Inc. contains information on single and double runner attrition mills.

335 Photometer, recording flow. Brochure from Research Specialties Co. describes applications of a new recording flow photometer for process control and analysis.

337 Processing Plants, packaged. Bulletin from Daffin Mfg. Co. describes modular equipment to form complete production system requiring reducing, mixing, blending.

339 Pumps. Brochure containing features, specs, operating data on line of V60 pumps available from W. R. Barry Pump Co.

340 Pump. Information from Eastern Industries, Inc. describes new self-priming, positive displacement, vane-type pump.

341 Pump, canned. Data Sheet from The Corley Co., Inc. provides information on a canned self-priming portable pump said to be the first of its kind.

342 Refrigeration, vacuum. Catalog from Croll-Reynolds Co. features vacuum refrigeration equipment.

343 Sampler, automatic. Bulletin S1-B8 from Denver Equipment Co. describes compact unit designed to provide motion to a cutter to obtain accurate samples.

345 Separators, micron-sized fines. Information for commercially available 3- and 6-ft. diam. superfine selector from Sturtevant Mill Co.

346 Spectrometer, mass. Bulletin 21130 from Consolidated Electrodynamics describes laboratory mass spectrometer.

347 Spray Machine. Bulletin 51 from Bowen Eng. Inc. discusses atomization techniques, spray machines, and different types of centrifugal atomizer wheels.

348 Strainers, polypropylene. Information available for new polypropylene strainers from Vanton Pump and Equip. Co.

349 Thermocouple Assemblies. Catalog 1890 contains specs and prices of line of thermocouple assemblies and pressure sealing glands from Conax Corp.

351 Turbine, gas. Bulletin 198 describes the 9000 hp single shaft gas turbine from Clark Bros. Co.

353 Valve, corrosion-proof. Data from Falls Industries, Inc. available for line of Impervite graphite drain valves.

354 Valve, fail-safe. Information on an 8-in., high capacity, fail-safe industrial valve with spring return available from Hydromatics, Inc.

355 Ventilators, plastic. Data Sheet E-7801 from Heil Process Equipment Corp. describes a solid plastic roof vent for removing corrosive fumes.

356 Waste Disposal Units. Bulletin WD-560 describes custom design services of John Zinc Co. for handling waste disposal problems.

MATERIALS *from page 122*

364 Metals, shielding. A 24-page Brochure from Knapp Mills Inc. contains cost analyses, corrosion data for the Insmetals.

365 Organic Chemicals, custom synthesis. A new catalog entitled "Production Chemicals and Custom Synthesis" is available from Elanco Products Co. (Eli Lilly and Co.).

366 Polyethylene. Information available for 15 new low and medium-density polyethylene formulations from Koppers Co., Inc.

367 Silicone Additives. Information for five new silicone additives, named Syl-ad, for improving paint application and appearance from Dow Corning Corp.

368 Urethane Foams. A new 24-page Brochure from Mobay Chemical Co. discusses the present and future scope of urethane foam products and markets.

369 Wire Cloth, teflon-coated. Information concerning a Teflon coated wire cloth is available from The Cambridge Wire Cloth Co.

A.I.Ch.E. Membership

Brochure—"Know Your Institute"—tells objective aim and benefits to chemical engineers who join this nation-wide organization, includes membership blank. Circle number 600 on Data Post Card.

Noel M. Champion *(left), Chief Engineer, Armour Agricultural Chemical Company, discusses a technical problem with* Robert L. Kietzman, *Sales Engineer, The Cooper-Bessemer Corporation, St. Louis District Office.*

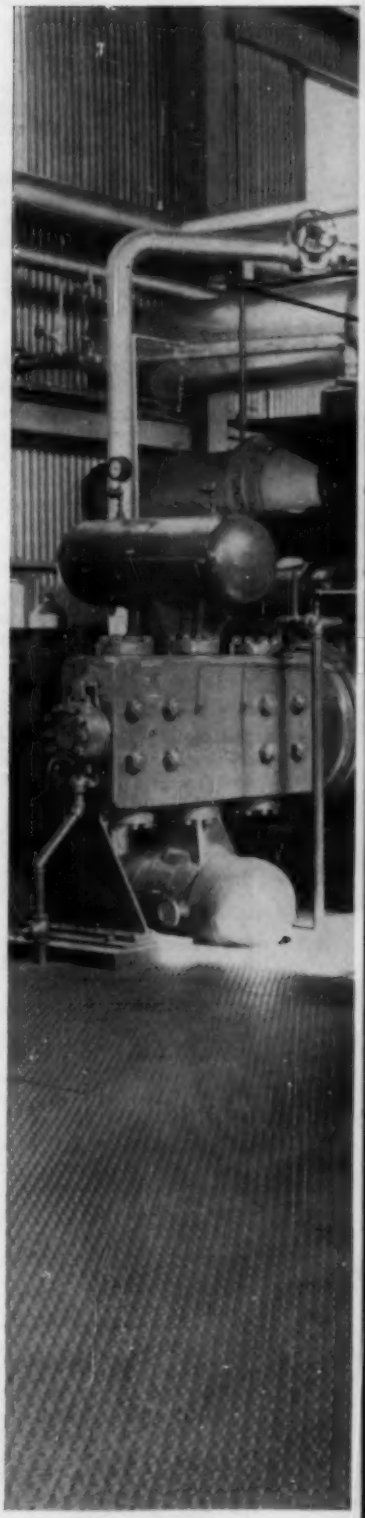
How Cooper-Bessemer service helps keep the ammonia flowing

At Armour Agricultural Chemical Co., Crystal City, Missouri, nine Cooper-Bessemer compressors play key roles in the manufacture of ammonia products. Round the clock, for five years, these units have given exceptional performance under the rigors of such problems as handling pressures up to 9000 psi.

The performance of these C-B compressors has been backed by Cooper-Bessemer engineers in the St. Louis area and in Mt. Vernon, contributing helpful service for these high-pressure operations.

Cooper-Bessemer engineers will gladly help *you* plan compression facilities, and demonstrate how this unique service works for your benefit. Call the nearest office.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester Pittsburgh • Detroit • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa New Orleans • Shreveport • Houston • Greggton • Dallas • Odessa • Pampa Casper • Seattle • San Francisco • Los Angeles • *SUBSIDIARIES:* Cooper-Bessemer of Canada, Ltd.... Edmonton • Calgary • Toronto • Halifax Stratford • C-B Southern, Inc.... Houston • Cooper-Bessemer International Corp.... New York • Caracas • Anaco • Cooper-Bessemer, S.A.... Chur, Switzerland • The Hague, Netherlands • Mexico City • The Rotor Tool Company... Cleveland

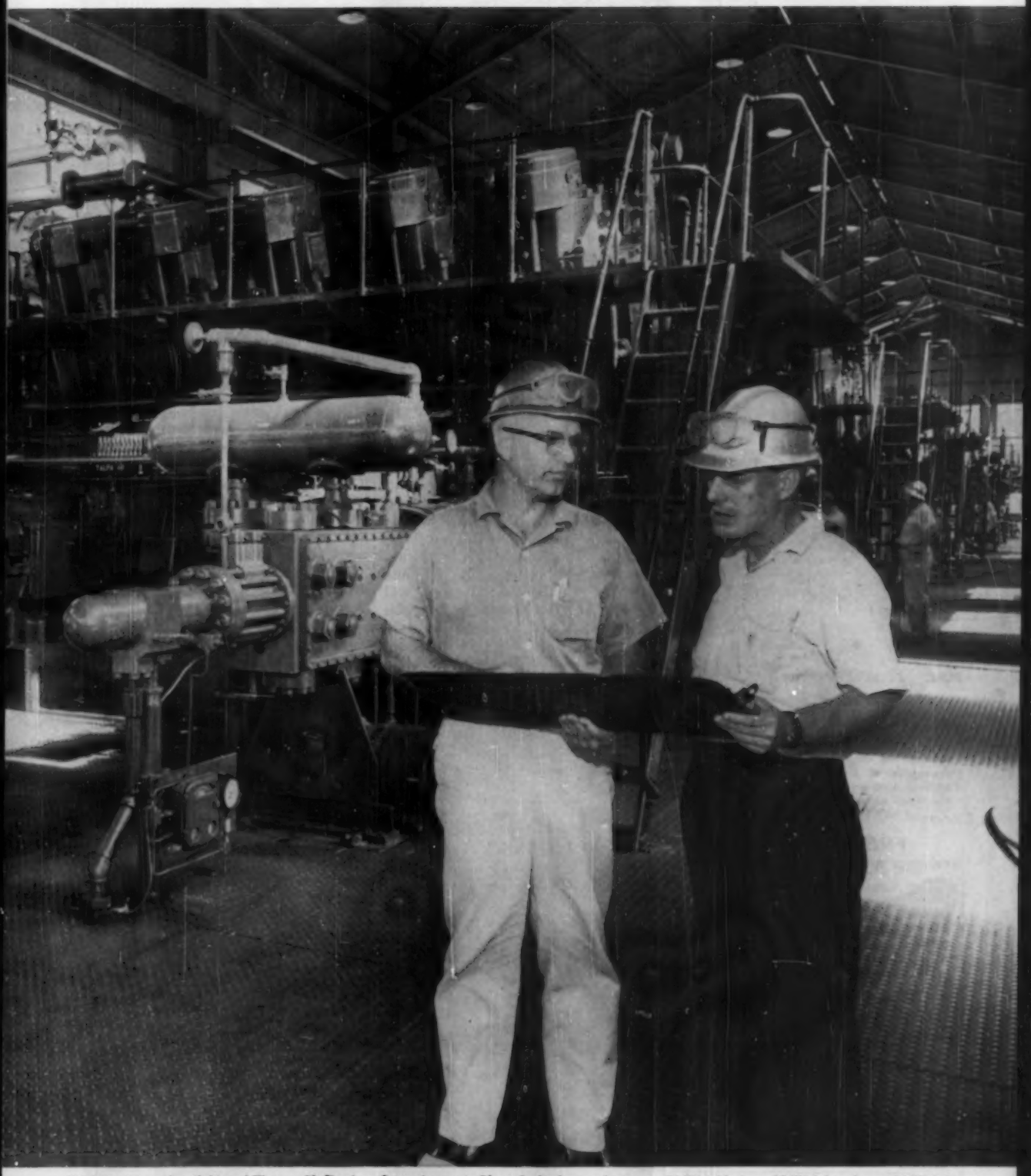


Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS • DIESEL • GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

For more information, turn to Data Service card, Circle No. 62



Noel M. Champion *(left)* and Thomas H. Ferebee, *Supt. Ammonia Plant. In background are two GMWA-10, four GMWA-8 and one GMWA-6 engine driven compressors for compression of air, natural gas, synthesis gas and ammonia. Armour also has two FM compressors for ammonia recirculators.*

meeting preview

D. O. Myatt,
Science Communications, Inc.

Washington round-up

Special events, extracurricular activities, plant trips, the ladies program for the coming National Meeting (December 4-7). George V. Allen, Director of U.S. Information Agency, will speak at Awards Banquet.

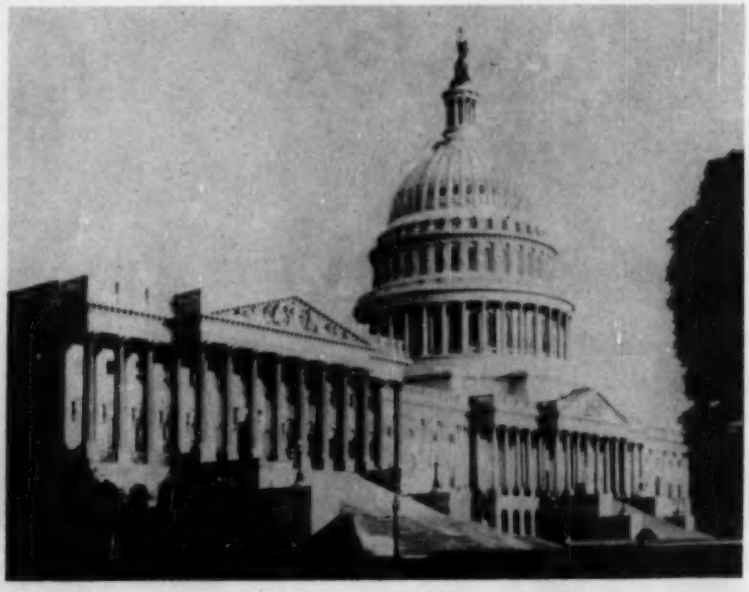
Early-bird feature at the coming Washington, D.C., Annual Meeting will be the Third Special Lecture, all-day affair on Saturday, December 3. This years subject, aimed at members with advanced knowledge in specialized fields of chemical engineering, is: Applied Mathematics in Chemical Engineering: Fundamental Ideas and Applications of Optimization Techniques in Design and Control. Speakers will be: Neal Amundson, Univ. of Minn.; Rutherford Aris, Univ. of Minn.; R. E. Kalman, Research Institute of Advanced Study, Baltimore, Md., and Leon Lapidus, Princeton Univ. The morning session will be concerned with the fundamental notions of logical search for optimal conditions, while the afternoon will be devoted to an "interweaving of the related areas of dynamic analysis, linear and non-linear stability and control, adaptive systems." The lecture is limited to 100 preregistrants—"first-come-first served"—so get your bid in early (A.I.Ch.E. members only). Preregistration forms were mailed with the program—get them in soon, deadline is December.

Extracurricular events

The Annual Meeting itself will get up steam at the traditional Get Acquainted Party on Sunday evening in the Presidential Ballroom of the Statler-Hilton.

Back to more serious business, Monday morning will be given over to the Twelfth Annual Institute Lecture. Honored this year will be Joel O. Hougen of Monsanto Chemical. His subject—Process Dynamics—Accomplishments and Prospects. The Institute Lecture will be followed directly by the annual business meeting of A.I.Ch.E. under the gavel of Jerry McAfee—there will be no technical sessions on Monday morning.

McAfee will, of course, also be the featured speaker at the President's Luncheon, Monday noon in the Congressional Room of the Statler-Hilton. This year's Professional Progress Award Lecture (8 P.M. Monday) will be delivered by William G. Pfann,



of Bell Telephone Labs. His subject, Zone Melting, will be of vital interest to all chemical engineers involved in the newer technologies for the production and purification of metals.

Tuesday double-header

Tuesday's program includes both a "pre-luncheon" address and a luncheon address. The former, at 11:15 A.M., will be a talk by Fred Singer, of the Univ. of Maryland, on Scientific Exploration of Space. At 12:15 P.M., Arthur L. Miller, director of the Office of Saline Water, will speak on "Give Us This Day Our Daily Water." Tuesday evening will see the Annual Awards Banquet, again in the Presidential Ballroom of the Statler-Hilton. Speaker will be the dynamic Director of the U. S. Information Agency, George V. Allen.

The program of special events will wind up at 11:15 on Wednesday morning with a second "pre-luncheon" talk by Wallace Brode, formerly Science Advisor to the Department of State, who will discuss Scientific and Engineering Planning.

Plant trips

A various and instructive roster of plant trips has been arranged by the local committee:

Monday morning

M-1. Public Buildings of Washington.

Monday afternoon

M-2. Atlantic Research Corp., Alexandria, Va.

M-3. David Taylor Model Basin, Carderock, Va.

Tuesday morning

T-1. U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

T-2. Mount Vernon, Va.

Tuesday afternoon

T-3. U.S. Naval Propellant Plant, Indian Head, Md.

T-4. U.S. Bureau of Mines, College Park, Md.

Wednesday morning

W-1. P.S. Naval Ordinance Laboratory, White Oak, Md.

W-2. National Bureau of Standards, Washington, D.C.

W-3. National Institute of Health, Bethesda, Md.

W-4. U.S. Naval Research Laboratory, Washington, D.C.

To the ladies

The ladies are of course more than welcome at the Sunday evening Get Acquainted Party. On Monday morning, after a get-together for rolls and coffee, a sight-seeing tour of Washington by bus will leave the headquarters

continued on page 130

Washington

from page 129

hotel at 9:30. Monday afternoon, a second bus tour will offer a choice between the Smithsonian Institute or the Capitol. At 5 P.M. on Monday, the Motion Picture Association of America has invited the A.I.Ch.E. ladies to have tea and to see a 30-minute color film (for 70 persons only —make reservations early). Monday evening is open for concerts, plays, and for enjoyment of Washington's fine restaurants.

Special Event: On Monday at 12:30 there will be a Fashion Show at the Mayflower, fashions by Jelleff's.

Tuesday will be taken up by a bus tour which includes visits to the Islamic Center, the Embassy of the United Arab Republic, and the Phillips Art Gallery, punctuated by lunch at the famous Cosmos Club. An alternate bus tour will visit George Washington's home at Mount Vernon, Virginia. Tuesday evening, the ladies are, as always, expected in their best togs at the Awards Banquet in the headquarters hotel.

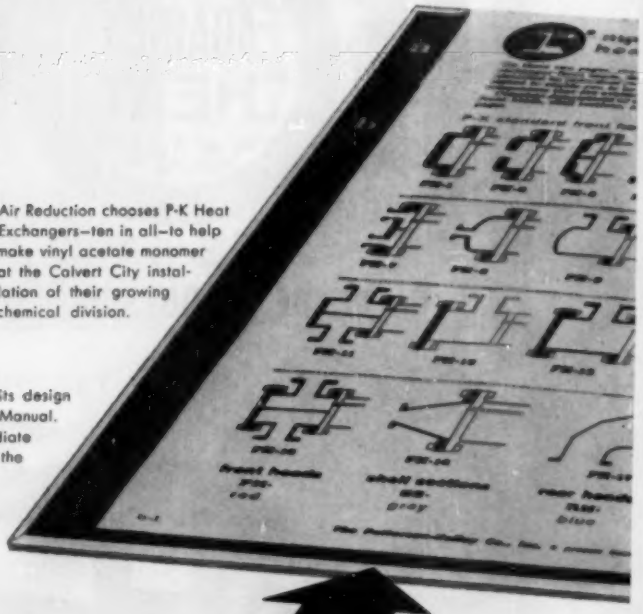
On Wednesday morning, the ladies program will wind up with a final bus tour of the Christmas Greens Show and the U.S. Botanic Garden, and a short movie in the afternoon on the history and local color of New Orleans, where will be held the February, 1961 A.I.Ch.E. National Meeting and the Petrochemical and Refining Exposition.

NEW P-K HEAT EXCHANGER MANUAL SIMPLIFIES SELECTING COMPONENTS FOR INSTALLATIONS LIKE THIS

The P-K HEAT EXCHANGER Manual is a new 108-page work book that makes selection of a heat exchanger far easier than ever before. It enables you and your engineering staff to save time, effort and duplication of work in developing a design that will meet all your performance conditions.

This new work book standardizes terminology. It illustrates and describes components commonly used in processing. It groups interchangeable front heads, shell sections and rear heads. In much the same way, it groups standard gasket joints, tube pass partitions and shell baffles, thus greatly sim-

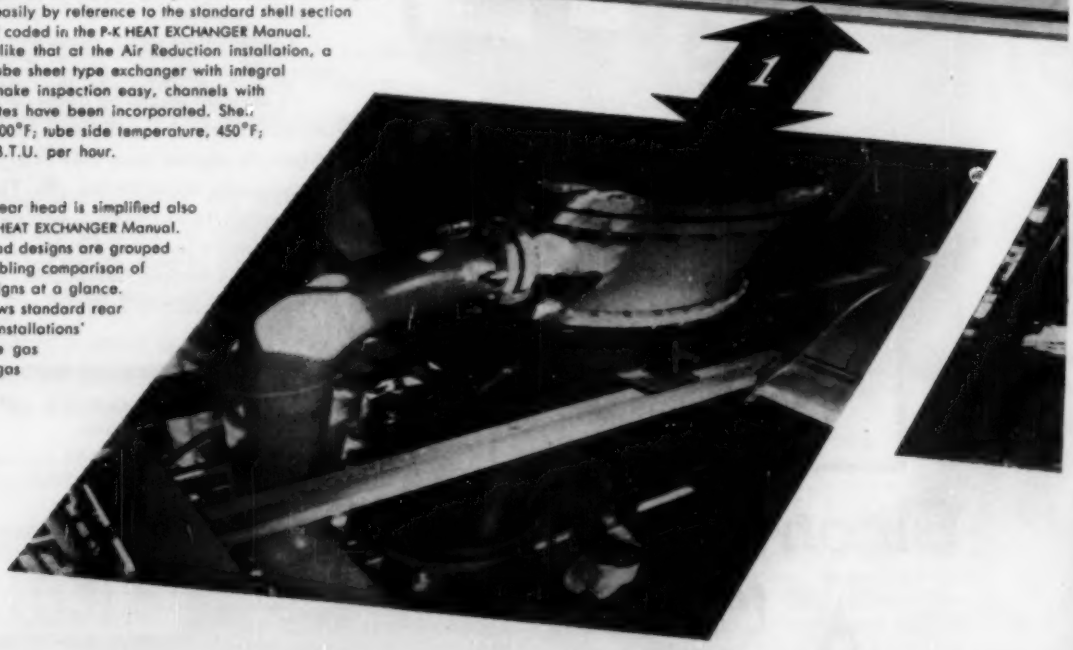
Air Reduction chooses P-K Heat Exchangers—ten in all—to help make vinyl acetate monomer at the Calvert City installation of their growing chemical division.



❶ Which type front head for your heat exchanger? You can "pinpoint" its design more quickly by reference to the head coding index in the new P-K HEAT EXCHANGER Manual. In the Air Reduction installation four P-K exchangers of the type at the immediate right cool crude product gas in the tube side by means of water flow through the shell side. Tube temperature is 300°F; shell temperature 150°F; capacity, 581,000 B.T.U. per hour.

❷ Shell sections, such as the one at right center, can be surveyed and specified more easily by reference to the standard shell section designs grouped and coded in the P-K HEAT EXCHANGER Manual. There are four units like that at the Air Reduction installation, a straight tube, fixed tube sheet type exchanger with integral expansion joint. To make inspection easy, channels with removable cover plates have been incorporated. Shell side temperature is 300°F; tube side temperature, 450°F; capacity is 580,000 B.T.U. per hour.

❸ Selection of rear head is simplified also when you use the P-K HEAT EXCHANGER Manual. Twenty-eight rear head designs are grouped and coded here, enabling comparison of the most popular designs at a glance. Photo at far right shows standard rear head on one of the installations' two refrigerated type gas cooler and liquid-to-gas heat exchangers.



plifying the underlying details of design.

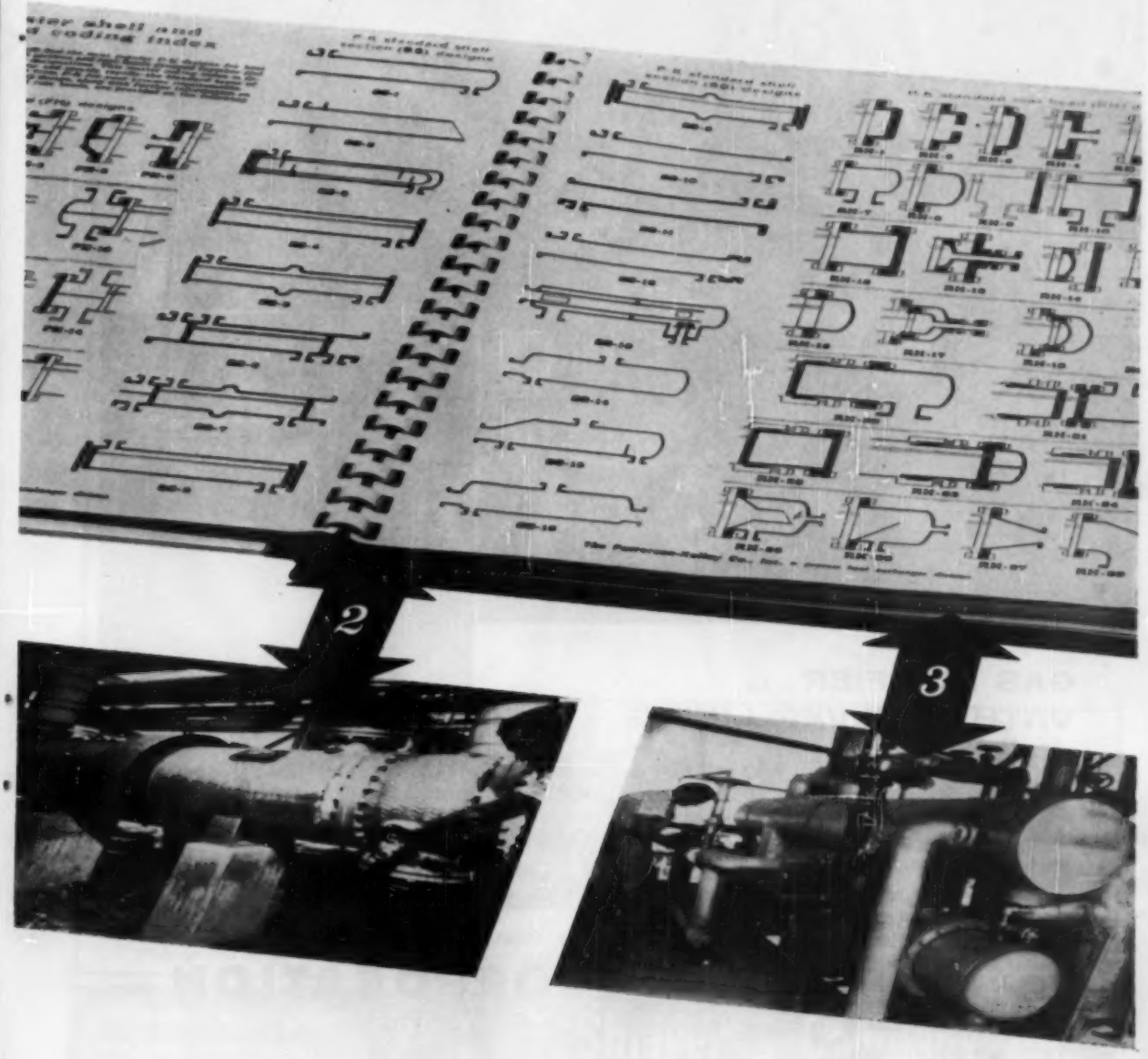
In other sections of the P-K HEAT EXCHANGER Manual you find an outline of the economic and performance advantages of principal designs, a review of the fundamentals of heat transfer, and a number of basic tables and formulas, along with a comprehensive design check list and other features.

As significant developments occur, the P-K HEAT EXCHANGER Manual will be supplemented and the new material sent to registered holders.

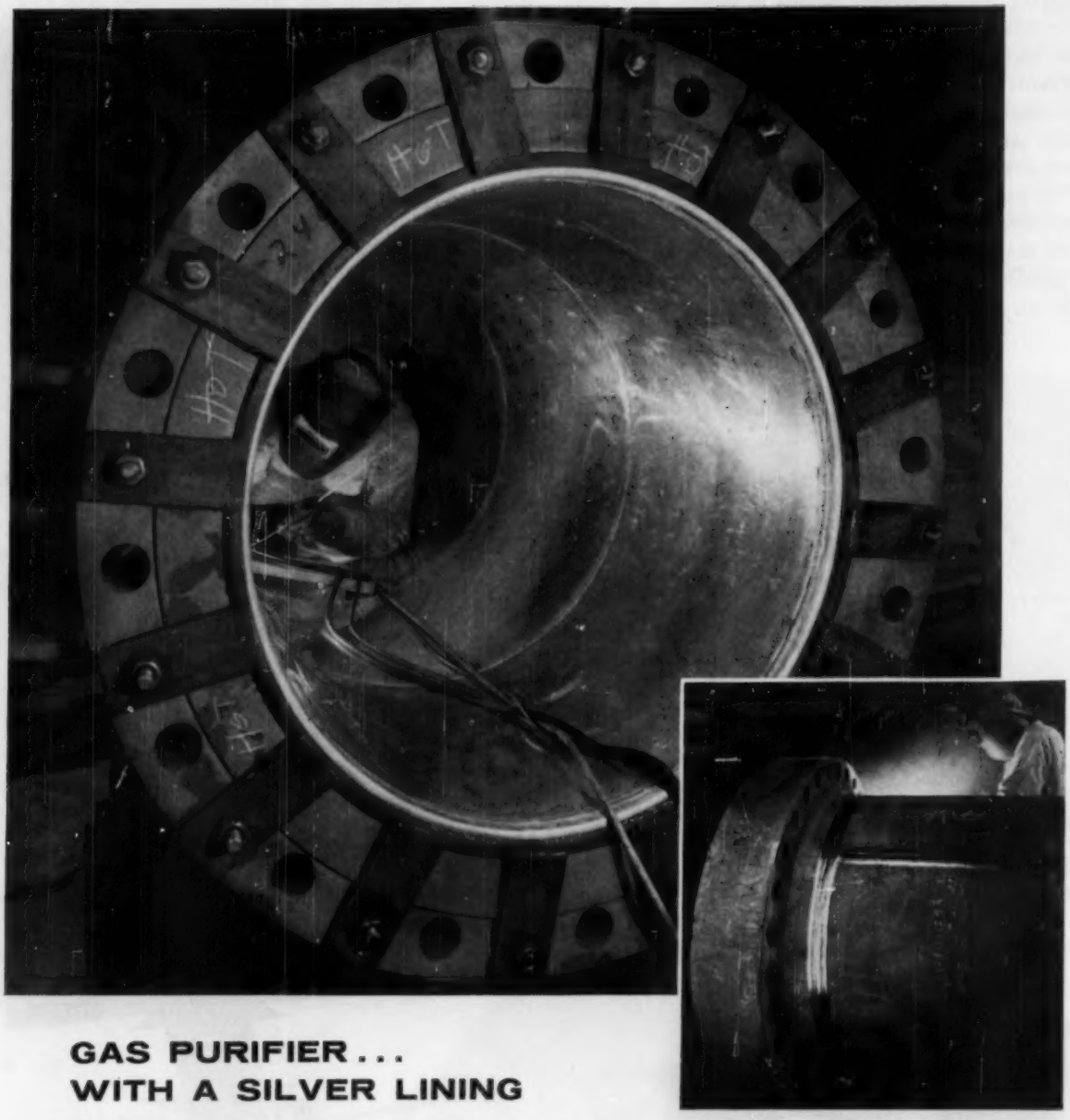
Available copies of this useful new manual are limited in number, and therefore are reserved primarily for those in the process industries who can best apply the information. If you design or specify heat exchangers, you are invited to write to us on your company letterhead, outlining briefly the areas of your interest. A few copies are available to students and non-technical personnel at a nominal charge. The Patterson-Kelley Co., Inc., 990 Burson Street, East Stroudsburg, Pa.

Patterson Kelley

Heat Exchanger Division



For more information, turn to Data Service card, circle No. 50



GAS PURIFIER . . . WITH A SILVER LINING

The Nooter welder pictured here is lining a high pressure reactor with a 1/16" thick pure silver sleeve. This is one of two identical units that include silver lined agitation shafts and connecting pipes.

In addition to a regular flow of steel vessels through the Nooter shops, the Nooter Alloy Department is constantly fabricating and developing new welding techniques involving all weldable materials, including stainless, nickel, aluminum, their alloys and clads, and silver, gold, Hastelloy, titanium, tantalum, zirconium and zircaloy-2.

Nooter customers benefit from the skill and experience of metal craftsmen who specialize in tough fabrication assignments. Whatever your tank or processing vessel needs, Nooter can produce it to your complete satisfaction. Why not put this ability to work for you?

For the latest Nooter publication, write for Bulletin 100, "Titanium Facts".

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Steel and Alloy Plate Fabricators and Erectors . . . "Boilermakers"

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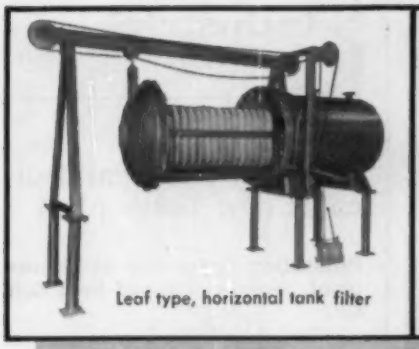
For more information, turn to Data Service card, circle No. 41



Leaf type, horizontal tank filter

Leaf type, vertical tank filter

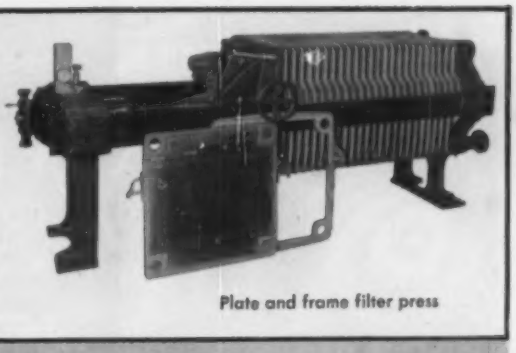
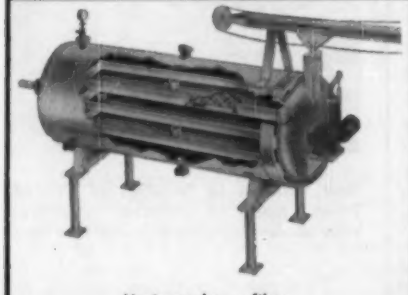


Plate and frame filter press

It's true—we build many types of filters

Rotary leaf type positive sluicing filter



Horizontal tray filter

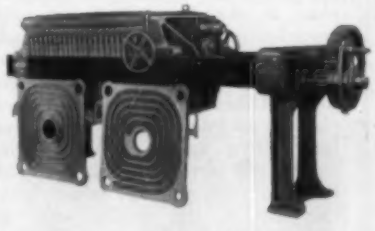
but primarily
WE SELL FILTRATION

The array of Shriver filters you see here represents various types we design and build for the process industries. But—more important—the kind of filter we recommend for your requirements is based on our technical investigations and laboratory tests to determine what is best suited for optimum operating efficiency and economy. Sometimes these analyses indicate the need for a filter not of our manufacture, and we tell you so frankly.

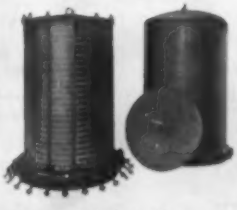
Such unbiased evaluations have helped build good will which our long experience has maintained at a high level.

That is why at Shriver's we try to "sell filtration," and the right filter for your process readily sells itself.

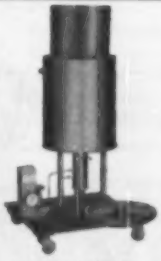
Let us work with you on your filtration improvement or expansion programs.



Continuous plate and frame slurry thickener and washer



Horizontal plate filter with hood type cover



Horizontal plate, tank type filter

Diaphragm pump for abrasive, corrosive materials

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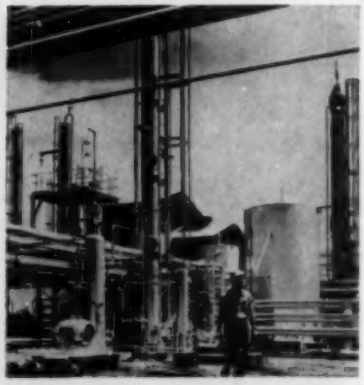
industrial news

Jefferson Chemical dedicates new Texas plant

Production under way at Conroe plant, recently acquired from Gulf Oil.

A MAJOR FACE-LIFTING job has been completed by Jefferson Chemical with the formal dedication of its new plant in Conroe, Texas, 40 miles north of Houston. The extensive chemical manufacturing facilities at Conroe were purchased recently from Gulf Oil, which, in turn, had acquired the plant from Warren Petroleum which first put up the unit in 1954.



New addition to facilities of Conroe, Texas, plant of Jefferson Chemical. View shows morpoline production unit.

"First-phase" modifications and required new construction have been completed, says Jefferson, and the plant is already turning out polypropylene glycol and propylene oxide triols, destined for use in manufacture of rigid and flexible polyurethane foams. Other products include morpholine, an intermediate used in surface active agents, rubber curing agents, and corrosion inhibitors. Plans for production of many other chemicals are in the works, says the company.

In addition to commercial production, the company will use the new plant for intermediate-scale production of new products coming from its Austin, Texas, research laboratories, for larger-scale development of new processes piloted at Austin, and for development of completely new processes.

An Air Liquide low-temperature separation installation at Petroleum Chemicals Inc., Lake Charles, La., U.S.A.
Products of the installation include oxygen and nitrogen in tonnage quantities and ammonia synthesis gas.

RECOVER HYDROGEN ECONOMICALLY

with your own low-temperature separation unit

The tremendous increase in the use of pure hydrogen by the ammonia industry — the largest market — and its increasing importance in space rocketry and missiles, have led to a need for even larger supplies. To tap the available rich sources, Air Liquide's low-temperature gas separation process offers many advantages in stripping hydrogen from refinery streams, coke-oven gas, and reformed natural gas, at low cost. This low-temperature process makes available the recovery of such valuable hydrocarbons as methane, ethylene, benzene, and liquefied petroleum gas fractions. Furthermore, it is the only hydrogen recovery process that preserves the thermal and chemical values of these hydrocarbons.

Our company's first low-temperature hydrocarbon separation plant went into operation in 1920. Since then, we have designed and built plants throughout the world. Air Liquide units lend themselves to remote operation with minimum supervision. With American Air Liquide you recover hydrogen at lower cost. Today, Air Liquide cryotechniques make possible the safe production, storage and delivery of hydrogen in tonnage quantities to any location.

If your problem is hydrogen recovery, purification or liquefaction, we can design and build units in a wide range of capacities from 25 tons to as high as 350 tons per day.

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- Coke-Oven Gas Separation • Helium Recovery
- Refinery Gas Separation • Pure CO Production
- Heavy Water for Atomic Reactors

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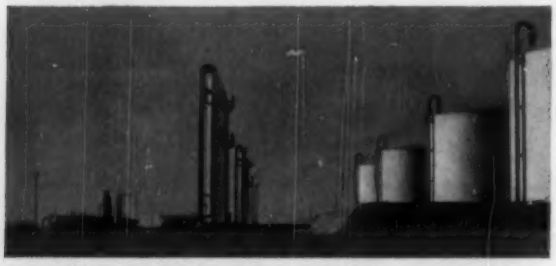
ENGINEERS AND CONSTRUCTORS FOR INDUSTRY

NEW PROCESSING PLANT AT HASSI-MESSAOUD STABILIZES 150,000 B/SD OF LIGHT CRUDE

The S. N. REPAL permanent field processing plant at Hassi-Messaoud, Algeria, is now operating at its capacity of 150,000 barrels per stream day of stabilized crude oil. The installation gathers, degasses, stores and transports a very light crude (0.8 sp. gr.) produced at the four-year-old Hassi-Messaoud field and destined for the Haoud El Hamra-Bougie pipeline to the Mediterranean. It was built by Societe Francaise des Techniques Lummus in this remote location, under extreme climatic conditions, in less than nine months from the time materials began to arrive at the site–and was completed ahead of schedule.

General view of the Hassi-Messaoud plant, showing vertical, third stage separators (center), part of horizontal separators, and four intermediate storage tanks.



Rear view of control house with its specially-designed roof for Saharan climatic conditions.

In May, 1958, Societe Francaise des Techniques Lummus was assigned the task of planning, engineering and constructing the plant, the primary purpose of which is to remove the very large quantities of natural gas associated with the Hassi-Messaoud crude (gas: oil ratio by volume is about 200:1). A temporary installation handling limited crude capacity existed at the site when the Lummus company was called in.

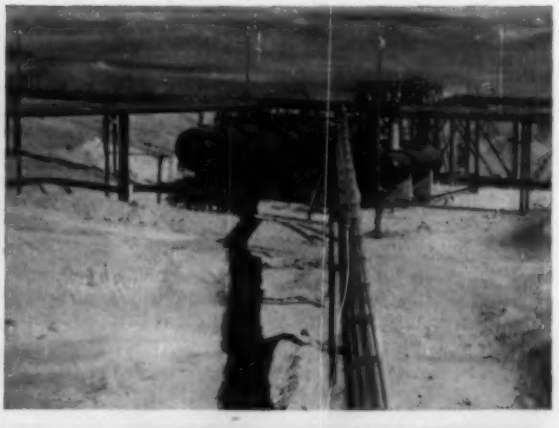
By September, 1958, plans were completed and purchasing began. Almost all the materials were bought in France or Algeria. However, electronic control apparatus was obtained in the United States. Over 4,000 tons of material were transported across the Mediterranean Sea, the Atlas Mountains, and the desert to arrive at a rocky plateau rising about 100 feet above the old dry valley of Oued Irara.

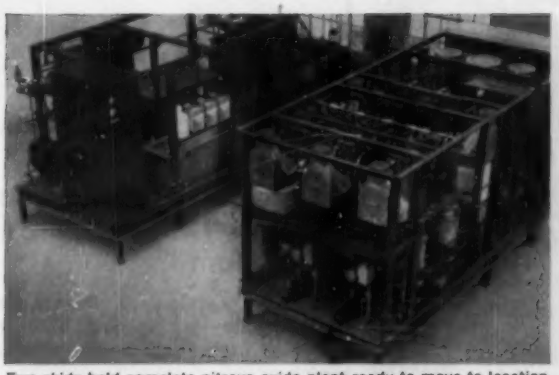
In addition to transportation difficulties, Societe Francaise des Techniques Lummus had these handicaps to overcome during construction proper, which got underway in January, 1959: a water table lying 150 feet deep, which posed problems in electrical grounding of equipment; conducting the major part of the work during the hottest months, with temperatures ranging from 104-130°F.; violent sand and dust storms, characteristic of the area.

In spite of the problems, on September 24, 1959 –ahead of schedule–the gas separators were put into operation and the flares lit. The first shipments through a 16-inch pipeline to Haoud El Hamra Terminal, 19 miles away, began shortly thereafter.

SFTL is one of the seven International Groups of Lummus companies which circle the globe to serve the process industries wherever plant design, engineering and construction are needed.

The condensate drums and control station with the high and low pressure flares.





Two skids hold complete nitrous oxide plant ready to move to location in "flying boxcar."

Portable Nitrous Oxide Generator Being Constructed for U. S. Army Engineers

Design, construction and testing of a portable nitrous oxide generator for the U.S. Army Corps of Engineers is being carried out by The Lummus Company at its Engineering Development Center, Newark, N. J.

The plant will afford a field supply of 40 lb. per hr. of liquid anesthesia for use under combat conditions, at a cost of about $250,000 per generator. The process, specified by the Army, is conventional decomposition of ammonium nitrate by heat. Ammonium nitrate can be shipped in bags, eliminating the return of empty anesthesia cylinders which presently causes problems.

Dimensions of the unit were dictated by the size of the rear door of a "flying boxcar". As designed, the plant is mounted on two skids, eight feet square by 20 feet long. It has shock and thrust resistance for portability by plane, train or truck. It is simple enough for operation by soldiers getting instruction from a manual.

The nitrous oxide product meets USP purity requirements.

The equipment in the unit includes:

On the first skid

Ammonium nitrate melting pots of aluminum.

Decomposition vessels of aluminum.

Caustic, sulfuric acid and steel wool scrubbers made of glass-fiber-reinforced polyester resin. Packings for the caustic and acid scrubbers are polyethylene Tellerettes.

On the second skid

Compressor of a type that compresses gas by flexing a diaphragm with hydraulic fluid.

Hot KOH absorber.

Desiccator.

Liquefier – a 1¼-ton fluorinated hydrocarbon refrigeration unit.

Stripper.

Bridging the two skids

A plastic gas-surge bag of 300 cu. ft. capacity which weighs only 30 pounds and folds up into a small bundle for storage. It consists of an inner envelope of vinyl plastic sheeting and an outer casing of vinyl-impregnated nylon fabric. It was specially designed for this portable plant.

Because parameters set by the Army pose many problems in selection of materials of construction, selection and positioning of equipment and instrumentation, Lummus' Engineering Development Center will provide the Army with an R&D prototype unit which may save them a great deal of expense and inconvenience.

FMC selects Lummus as principal sub-contractor on new Army Chemical Corps Contract

A new Army contract for a Chemical Corps production facility near Newport, Indiana, in excess of $13,000,000, has been awarded to the Food Machinery & Chemical Corporation. The contract calls for the design, construction and test operation of a plant to produce classified material. The Lummus Company has been selected as principal sub-contractor to design, construct and assist in test operation. Food Machinery & Chemical Corporation have the responsibility for operating this government-owned contractor-operated facility for some period to follow.

industrial news

Heat Transfer Division sponsors Washington symposium

Ten-paper session at December National Meeting will cover wide range of theoretical and practical topics.

A ONE-DAY SYMPOSIUM on Heat Transfer at the Annual A.I.Ch.E. Meeting in Washington, D.C. (December 4-7) will be sponsored by A.I.Ch.E's Heat Transfer Division. The two-session symposium will include discussion of iteration methods of solving heat transfer equations, heat and mass transfer in packed and fluidized beds, analogies between heat, mass, and momentum transfer, heat transfer from flames and chemically-reacting systems, effects of acoustic vibrations on forced convection.

Sponsorship of heat transfer symposia is only one of the activities of the Heat Transfer Division. Main responsibility is organization of the National Heat Transfer Conferences, in cooperation with the Heat Transfer Division of ASME. The fourth conference of this type, held August 14-17, 1960, at Buffalo, N.Y., drew an attendance of well over 800 to hear more than 70 technical papers and a series of panel discussions on practical heat transfer topics. Host for this Buffalo conference was A.I.Ch.E., which will also have the responsibility for the 1962 get-together. In 1961, the Division will cooperate in the International Heat Transfer Conference, to be held in Boulder, Colorado, August 28-September 1.

Sun Chemical has moved its Michigan Research Laboratories into expanded facilities at the Wood River Junction, R.I., main plant of the Sun Warwick Chemical Division. The greater production facilities will enable the company, it is felt, to increase service to the paper industry, particularly in connection with the fibre activator process. This process involves the addition of specific chemicals at the wet-end of paper machinery to enable incorporation into paper, board and formed pulp articles of such additives as resins, pigments, rubbers and others.

CUT FUEL BILLS 20% WITH A LJUNGSTROM® AIR PREHEATER

The world's largest fluid catalytic cracker at Esso's Bayway Refinery is equipped with a new Ljungstrom Air Preheater. This picture shows the half-ton cold-end elements being installed in the Ljungstrom rotor.

Your biggest refinery operating expense is the money you burn: fuel costs. You can chop fuel bills ⅓ with a Ljungstrom Air Preheater, and here's how:

Your fuel bill drops about 1% for every 45-50°F you raise the temperature of combustion air. Ljungstroms now in service raise the air temperature 1000°F or more – and the rest is simple arithmetic. With a Ljungstrom, four barrels of fuel do the work of five. On fuel savings alone, one eastern refinery came up with net savings of $67,800 in the first year they used a Ljungstrom.

SAME FUEL, MORE HEAT. Ljungstrom economy is flexible economy. If total throughput is more important to you than fuel savings, a Ljungstrom can help boost the capacity of a pipe still at least 10% a day, without any increase in fuel consumption.

THESE ARE FACTS backed up by 25 years of Ljungstrom performance in refineries all over the world. But they're not the only facts. To find out about Ljungstrom's low-cost maintenance, easy inspection, in-service cleanability, space-saving compactness, call or write The Air Preheater Corporation for a free copy of a brochure called "The Ljungstrom Air Preheater for Process Equipment."

THE AIR PREHEATER CORPORATION

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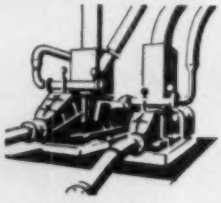
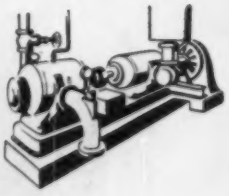
FULLER EQUIPMENT

for the process industries

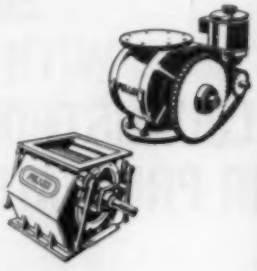


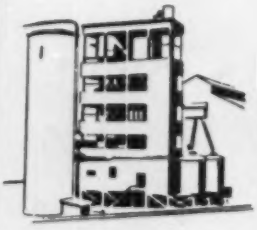
Pneumatic Materials Handling Systems. Widely specified throughout the process industries, Fuller's range of equipment offers best single source for solving problems in moving dry bulk materials pneumatically. Fuller-Kinyon Pumping Systems, Airveyor® Pressure and Vacuum Conveying Systems, and F-H Airslide® Fluidizing Conveyors are completely sealed to prevent both contamination of the product and any leakage of dust, etc., into the surrounding area. They are used to move dry, granular and pulverized materials to and from cars, ships, trailers, storage and processing points.



Fuller Rotary Compressors and Vacuum Pumps are vibration-free, can be installed anywhere, even on balconies. Fewer moving parts mean minimum maintenance. Compressors and Vacuum Pumps handle air and gases from 30 to 3300 cfm at pressures to 125 lb. gage. Vacuums to 29.95 in. (referred to 30-in. barometer).

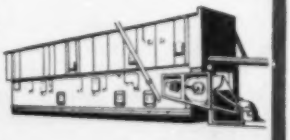
Fuller Vane-type and Roll Feeders . . . for volumetrically controlled feeding of a wide range of dry pulverized or granular materials. Also Fuller Rotary Valves . . . used under silo deck slabs and bins to permit the free flow of pulverized materials which tend to arch, such as lime and cement raw materials.





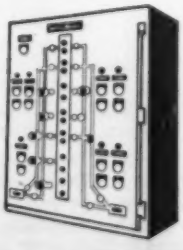
Fuller Preheaters, Humboldt Suspension Type . . . for preheating dry, pulverized Portland cement raw materials with rotary kiln waste gases.

Fuller Horizontal and Inclined Grate Coolers are compact, easily installed for fast, efficient cooling of materials such as nodulized phosphate rock, pebble lime, ores, dolomite, iron nodules and Portland cement clinker from 2800°F. or higher to any desired point within a reasonable range of atmospheric temperature.



Fuller-Material-Level Indicators signal audibly and visibly when materials reach a predetermined high or low level. Controls conveyor motors, valve circuits, etc.

Fuller Control Panels permit automatic, remote, one-man control of multiple operations. Easily-read panel permits visualizing flow of material to storage or from process bins.



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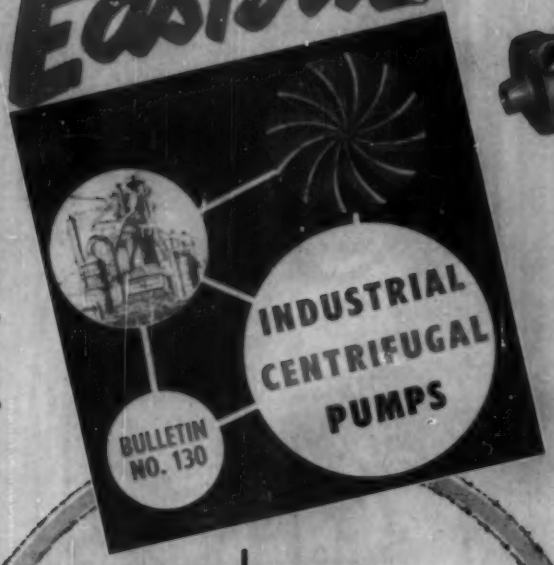
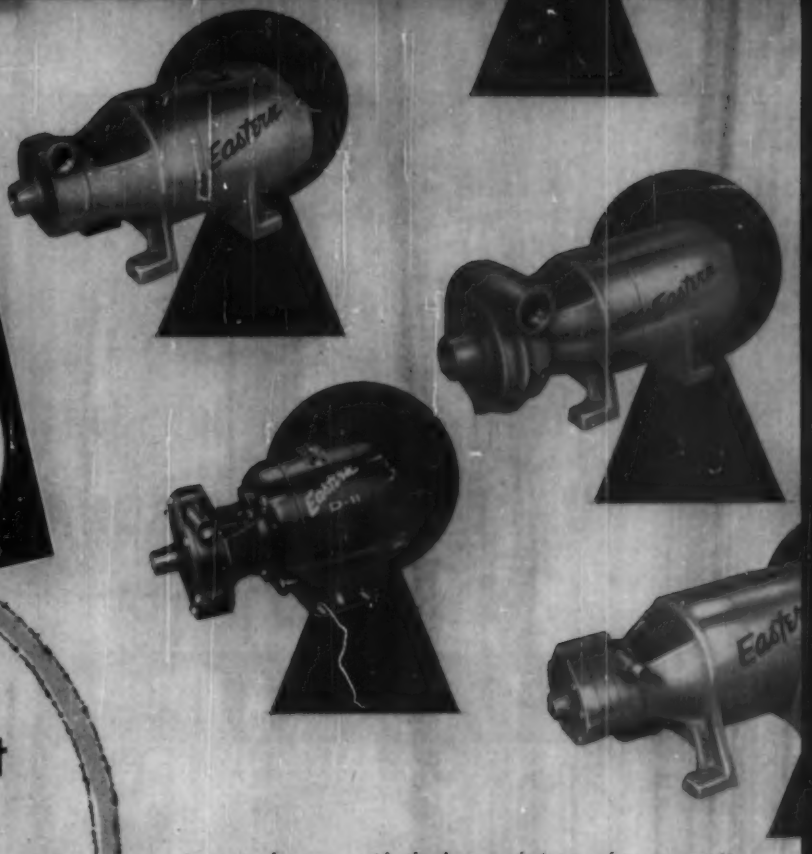
For more information, circle No. 10 ➤

Eastern





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If you need centrifugal pumps with these characteristics, this reference book is for you:

- PRESSURES: to 21 psi in single stage pumps; to 70 psi in multi-stage types.
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- MOTORS: standard motors for 115/230 volts 60 cycles 1 phase (other electrical characteristics available). Power range from ⅓ to 1½ H.P.
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- METALS: your option of cast iron, bronze, stainless steel, Monel, Cast Iron, Hastelloy "C".
- INSTALLATIONS: a wide range of transfer, recirculation, feed, boost and filter-pumping applications.

All told, 50 different models are described in full — and you get a wealth of technical data as well. Write for new catalog 130 now!

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industrial news

Refineries for Thailand, Guatemala

Two small countries will get their first complete petroleum products facilities

THAILAND AND GUATEMALA, almost at opposite poles of the earth, will be the sites of two new oil refineries.

The Thailand refinery, to go up outside Bangkok, will have a capacity of 5,000 barrels per day, will cost more than $19 million, says Hydrocarbon Research which has contracted to furnish engineering services for Commentry-Oissel Cie., France.

According to present plans, the refinery will deliver a wide range of products including two grades of motor gasoline, several grades of aviation gasoline, jet fuel, two grades of diesel fuel, heating fuel oil, kerosene, and liquid petroleum gas. A bottling plant for the LPG will be attached to the main unit. Also included in the plans is an asphalt blowing plant aimed at road construction.

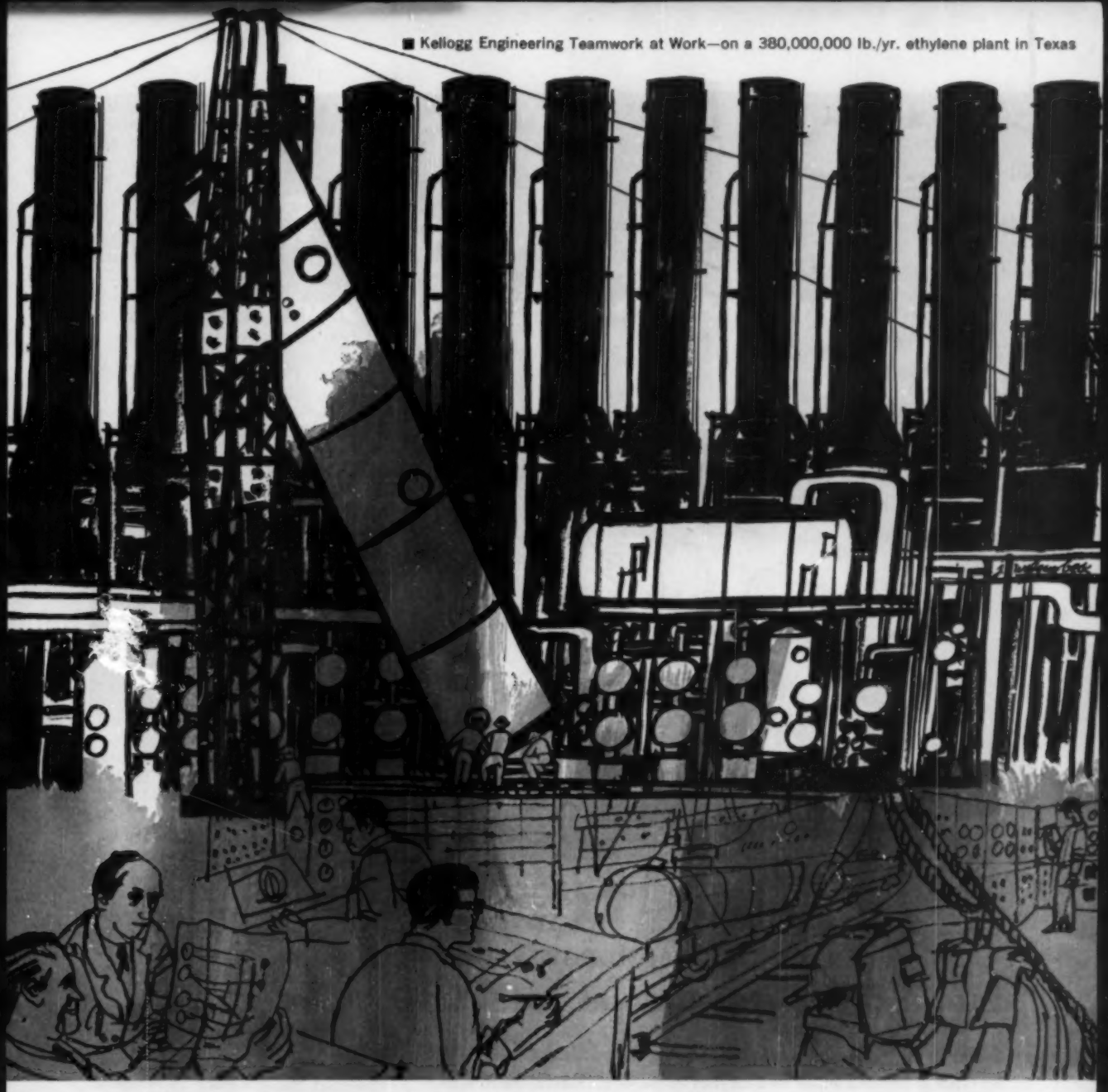
This first complete refinery for Thailand will be operated by the contractor for the Thailand government. Crude will be purchased in the open market.

Another "first" is the 4,000 per day refinery to be installed near Puerto Barrios, Guatemala. The unit will be designed, engineered, and constructed by Lummus for the Breaux Bridge Oil Refining Co. of Houston, Texas. Due to weather conditions in Guatemala (190 inches of rainfall annually), and lack of trained construction labor, the plant will be almost entirely prefabricated and skid-mounted for transport.

The new Central American refinery will include a crude topping unit with a capacity of 4,000 barrels per day, a desulfurizer (2,600 barrels), and a catalytic reformer (1,200 barrels). It will produce premium and regular gasoline, kerosene, fuel oils, and other specialty products.

A carbon black paint with initial capacity of 64 million pounds will be built in Southern California by United Carbon. The pacific coast market will be served by the unit, scheduled to go on stream in 1961.

■ Kellogg Engineering Teamwork at Work—on a 380,000,000 lb./yr. ethylene plant in Texas



CHEMICAL PLANTS FROM SCRATCH

For many of the world's leading chemical and petrochemical firms, the Kellogg method of executing a capital investment in new plants and plant expansions has proved the soundest way to minimize expenditure.

This economic route to new chemical plants consists of coordinating and controlling all phases of engineering, procurement, and construction under an internationally integrated management. It is founded on close teamwork among all Kellogg operations at home and abroad . . . and with client engineering staffs.

Kellogg's method has improved process and plant engineering . . . saved money in procuring materials and equipment . . . increased labor productivity . . . expedited erection . . . achieved the earliest possible on-stream dates . . . and stayed within predetermined costs. The result is the plant which achieves the optimum balance of investment and operating costs.

Working with clients on this basis, Kellogg has been responsible for a variety of chemical plants throughout the world. In the United States, current projects include: a 380,000,000 lb./yr. ethylene plant in Texas; an 18,000,000 lb./yr. epichlorohydrin plant in New Jersey; a 300 ton/day ammonia plant in Missouri; a 200 ton/day urea plant in Delaware.

If you are planning to build new processing facilities in the U.S. or overseas, Kellogg would be glad to show you how its engineering teamwork could work to your company's advantage. Please address inquiries to The M. W. Kellogg Company, 711 Third Avenue, New York 17, N.Y.

THE M. W. KELLOGG COMPANY / A Subsidiary of Pullman Incorporated

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M KELLOGG W

industrial news

Monsanto, Witco up phthalic capacity

Badger Manufacturing, Scientific Design awarded design and engineering contracts.

CONSTRUCTION OF PLANTS for phthalic anhydride continues apace, as both Monsanto Chemical and Witco Chemical announce building plans.

Monsanto's new facilities, to be located in Gloucester County, New Jersey, opposite Chester, Pa., will increase the company's phthalic anhydride capacity by "more than 30%, and its phthalate ester capacity by more than 50%." The New Jersey plant, which will supplement Monsanto's production at Everett, Mass. and St. Louis, Mo., will use the Sherwin-Williams fluid-bed catalytic process, licensed through Badger Manufacturing. Design, engineering, and construction have been contracted to Badger.

Witco's scheduled "Eastern" plant (no location disclosed) will be designed and constructed by Scientific Design using an SD process. Capacity will be 30 million pounds per year, completion is slated for late 1961. Witco's first phthalic anhydride plant went on stream early this year in Chicago, was also designed and constructed by Scientific Design.

Scientific Design has also been busy in the phthalic field in Europe. One plant, under construction for Compagnie Francaise des Matieres Colorantes (Francolor) at Villers-St-Paul, France, will use ortho-xylene as initial feedstock. Engineering and construction will be carried out in France by a member of the SD group, Societe Francaise des Services Techniques. Also building is another SD phthalic anhydride plant for Staatsmijnen, in Limburg, Geleen, Holland.

Two aromatic chemicals plants in Europe will be constructed under a joint-venture agreement betwen California Chemical and the British Petroleum Co. The units, to be located near existing BP refineries on the Isle of Grain, Kent, England, and Dinslaken, West Germany, will be operated by British Petroleum on behalf of the jointly-owned company, "BP California." Products will include orthoxylene, ethyl benzene, paraxylene. Construction contracts for the Kent plant are being negotiated with Badger and Bechtel-Wimpy, reports California Chemical, while no contracts for the German plant have yet been signed. Cost of the whole venture is said to be about $20 million.

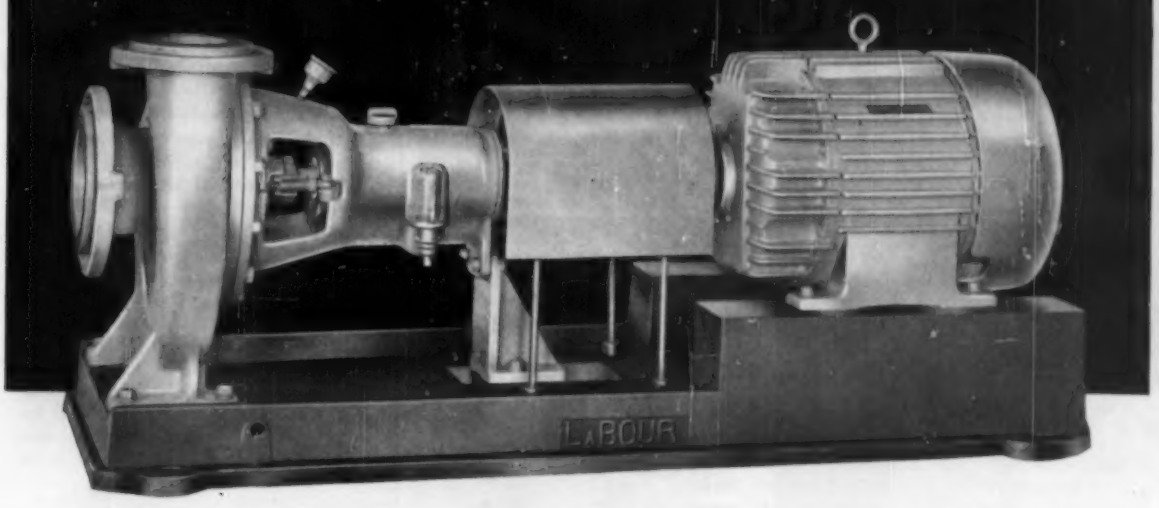
An agreement providing for an exchange of information on boron compounds has been completed between Imperial Chemical Ltd. and Callery Chemical. Terms include an exchange of assessment information in certain aspects of the field of boron compounds with a view to the acquisition by either party of non-exclusive rovalty bearing licenses under the other party's patents as requested. Related technical information may also be made available for use on terms to be agreed.

A refinery to be located in El Salvador, Central America, will process 10,000 barrels of crude oil a day. Refineria Shell de El Salvador S.A. will construct the plant at Acajutla. Included are a crude unit, hydrodesulfurizer, platformer, tankage and offsite facilities.

Now–

Famous La Bour "Q" Performance

Plus New Servicing Advantages



For many years LaBour Type Q pumps (non-priming) have been setting industry records for sustained efficiency and freedom from vapor- or air-binding. Now this same remarkable pump is available as Type SQ, so constructed that the impeller and all other rotating parts may be removed or replaced without disturbing pipe connections or motor.

Type Q and the new SQ pumps reduce liquid travel within the casing to *less than one revolution of the impeller*. This fact, together with other design features, produces efficiencies as high as 80% and more, with an open impeller and no close clearances inside the pump. Since performance does not depend on close clearances, relatively great increases due to corrosion or wear have negligible effect on the efficiency of these pumps.

If you want to know how either of these units can help to reduce liquid-handling costs in your plant, write for our new bulletin on Q and SQ pumps.

ORIGINAL MANUFACTURERS OF THE SELF PRIMING CENTRIFUGAL PUMP

LABOUR

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industrial news

Construction of a liquid sulfur dioxide plant is underway at Stauffer's Baton Rouge, La., plant. The Consolidated Chemical Industries Division of Stauffer project will have a rated capacity of 10,000 tons a year.

Design and construction plans are going ahead for a new laboratory at the Union Carbide Olefins Technical Center in South Charleston, West Va. The Lab will centralize the R&D and special instrumentation departments of the company which are now at the Institute, and South Charleston, West Va. plants. While most of the building will be occupied by the Olefins Company, additional facilities will be provided for the Union Carbide Chemicals Research Department.

In a further move into chemicals, Standard Oil of California is consolidating its chemical interests into one subsidiary, California Chemical Company. Under this new arrangement, Oronite Chemical, Socal's industrial chemical organization, becomes the Oronite Division of California Chemical.

A 20,000 barrel a day U.O.P. Unifiner-Platformer will be added to the Iranian Oil Company refinery at Abadan, Iran. The $5 million contract for design and construction of the unit was awarded to Fluor-Schuytvlot N.V., Holland. Schedule date for completion is 1962.

A maleic anhydride plant to be built at Meerbeck, Germany, will have an initial design capacity of 13,200,000 pounds a year. Rheinpreussen A.G., Homberg, Neiderrhein, is one of the first companies in Germany to use Scientific Design's maleic process.

Houdry Process Corp. and the West German firm, Chemische Werke Huels, have formed a jointly owned company to develop, manufacture and sell each company's line of catalysts. The new firm, Katalysatorenwerke Houdry-Huels F.m.b.H., will be located in Marl, West Germany.

ECO ENGINEERING NEWS

the big name in small pumps for the process industries

• New at ECO •

Larger GEARCHEM Pumps

Eco GEARCHEM Pumps, formerly made only in ¾ in. and ¾ in. port sizes for capacities up to 3 gpm. and 10 gpm. respectively, are now available in the new 900 Series with 1½ in. ports and comparable higher capacities, greatly enlarging its range of service applications.

Two models are available; either with threaded ports or with integrally cast 150 lb. A.S.M.E. flanges, as illustrated.

SUBMERSED Pump

In such services as pumping out vessels under high vacuum, pumping high temperature materials, and pumping out of vacuum into atmosphere, this submersed GEARCHEM pumping unit eliminates problems of shaft seal leakage, heat-traced plumbing, low NPSH, etc.

Eco Pumps Serve Producers of Rare Biochemicals Used to Study the Chemistry of Life Itself

Schwarz Biochemicals and Radiochemicals are known and used by medical and biochemical institutes throughout the free world.

Products of Yeast

"About 20 years ago," states Mr. David R. Schwarz, President of Schwarz BioResearch, Inc., "we had the idea that biochemicals, produced by yeast, might be useful for investigation in biological and medical science, if we could learn how to extract and purify them economically. Our parent company, Schwarz Laboratories, Inc., with 80 years of experience as consultants to the brewing and food industry, furnished an ideal background for such a program.

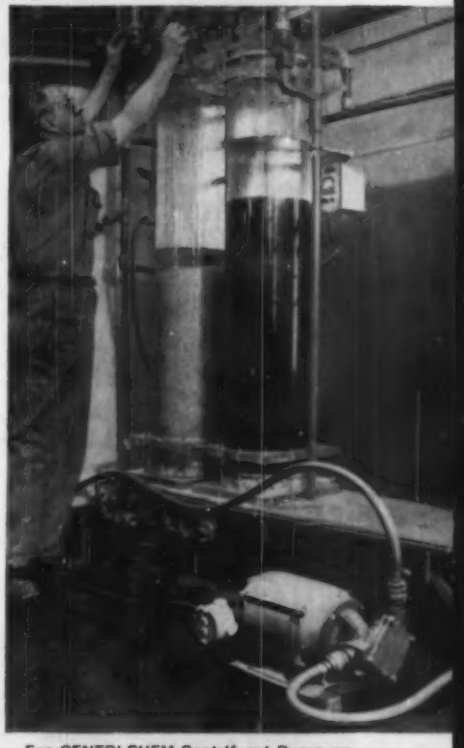
Stimulated by Biological Research

"The rapid expansion in biological research throughout the world greatly extended our original plans. Today the Schwarz price list includes 250 products extracted from natural sources or synthesized.

New Frontiers of Medicine

"These included both deoxyribonucleic and ribonucleic acids and their derivatives, of which Schwarz are leading or exclusive producers, as well as tritium-bearing compounds which have made possible entirely new types of investigation into the chemistry of nucleic acids and living cells. It is this research of today that leads to tomorrow's new drugs and medicines."

Eco GEARCHEM Gear Pump of 316 stainless steel with Teflon gears and bearings meters brewing water alkalinity corrective into 5 gallon containers at neighboring plant of Schwarz Laboratories, Inc. Metering is controlled by pump revolution counter and accuracy is maintained within ± 1%.



Eco CENTRI-CHEM Centrifugal Pump on portable skid alternates between several duties. Here it is pumping deionized water at Schwarz BioResearch, Inc.

Eco Pumps Serve Exacting Needs

Eco CENTRI-CHEM Centrifugal Pumps of Carpenter 20 stainless steel with Teflon and ceramic mechanical seals offer the ultimate in a chemically sterile, mechanically trouble-free pump. At Schwarz BioResearch, they are in such services as handling deionized water; pumping caustics (from the 3rd to the 5th floor of plant); recirculating slurries in scrubber of spray dryer, etc.

These CENTRI-CHEM pumps have been in service for periods of from 10 months to more than two years with negligible downtime for repairs.

ECO Products for Handling Corrosive and Hazardous Processing Fluids

ALL-CHEM® Rotary Pumps
MINILAB® Rotary Pumps
GEARCHEM® Gear Pumps
CENTRI-CHEM® Centrifugal Pumps
PUMPMOBILE® Portable Pumping Units
GEAR-VAC® Valves
CHEMICAL DISPENSING VALVES
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Ask for literature on any or all of these ECO Products

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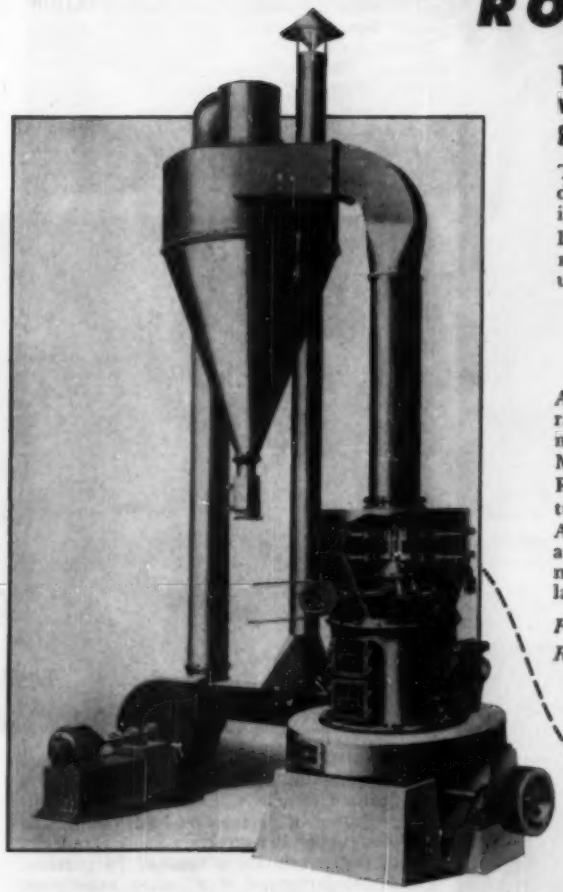
roll up new production... and profit...records

with

Raymond ROLLER MILLS



RAYMOND MULTI-PURPOSE ROLLER MILL WITH DOUBLE WHIZZER AIR SEPARATOR

Top performing RAYMOND Multi-Purpose ROLLER MILLS with WHIZZER AIR SEPARATION lead the field in fine grinding in the CHEMICAL and PROCESS INDUSTRIES.

This Mill combines the Raymond High Side Roller Mill and the double Whizzer Separator to afford great versatility and economy in the handling of many fine grinding problems.

Its wide scope of application covers the preparation of powdered materials . . . from simple fillers to fancy chemicals. Typical products pulverized include . . .

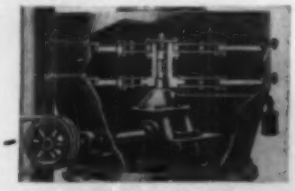
PIGMENTS • FULLERS EARTH • INSECTICIDES • IRON OXIDES • TALC • BARYTES • KAOLIN AND CLAYS • SULPHUR • CARBON MIXTURES • STARCH • LIMESTONE • BAUXITE • CALCIUM SILICATE • MINERAL FILLERS • PHOSPHATE ROCK • GYPSUM.

A single, easy adjustment of the Whizzer controls the fineness range from 20-mesh grades to products essentially all minus 325-mesh.

Mill capacities reach 40 tons per hour and more with a Super Roller Mill. Flash Drying Accessories may be installed when moisture removal is required.

All aspects of Fine Grinding are combined in a clean, dust-free, automatic system that is economical in operation and maintenance. Installations are flexible and readily adaptable to any plant layout.

For detailed information send for the Raymond Roller Mill Catalog Number 79C



Mills are available with Single or Double Whizzer Separators. Whizzers have set of radial blades attached to a disk that revolves on a vertical shaft in separating chamber. Variable speed drive insures finger-tip control of fineness.

COMBUSTION ENGINEERING, INC.

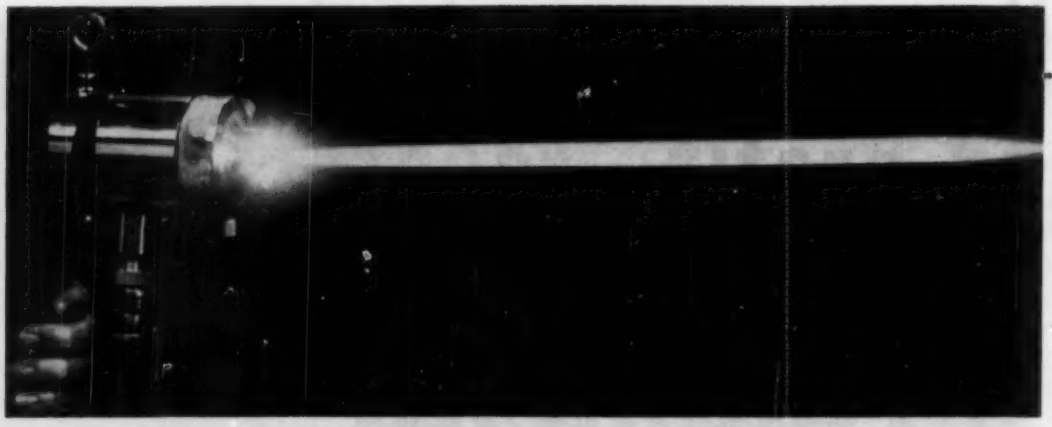
427 W. RANDOLPH ST.
CHICAGO 6, ILLINOIS

Raymond Division

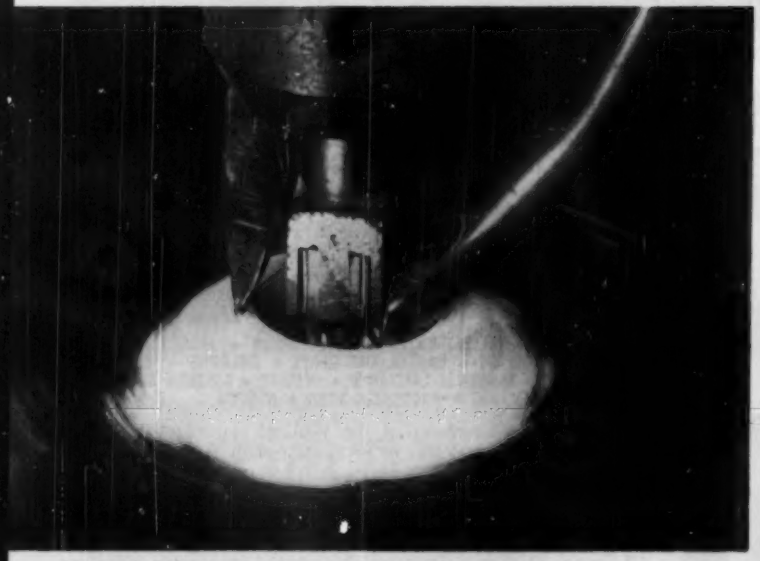
SALES OFFICES IN PRINCIPAL CITIES

Combustion Engineering-Superheater Ltd., Montreal, Canada

For more information, turn to Data Service card, circle No. 99



ADVANCEMENTS IN ULTRA-HIGH heat applications are the result of new electrode designs in Thermal Dynamics Corp.'s plasma flame torches. The quiet, low velocity flame of helium plasma pictured above can reach 50,000 °F. Chemical industry applications include: reduction processes, free radical work, and hydrocarbon reformation.



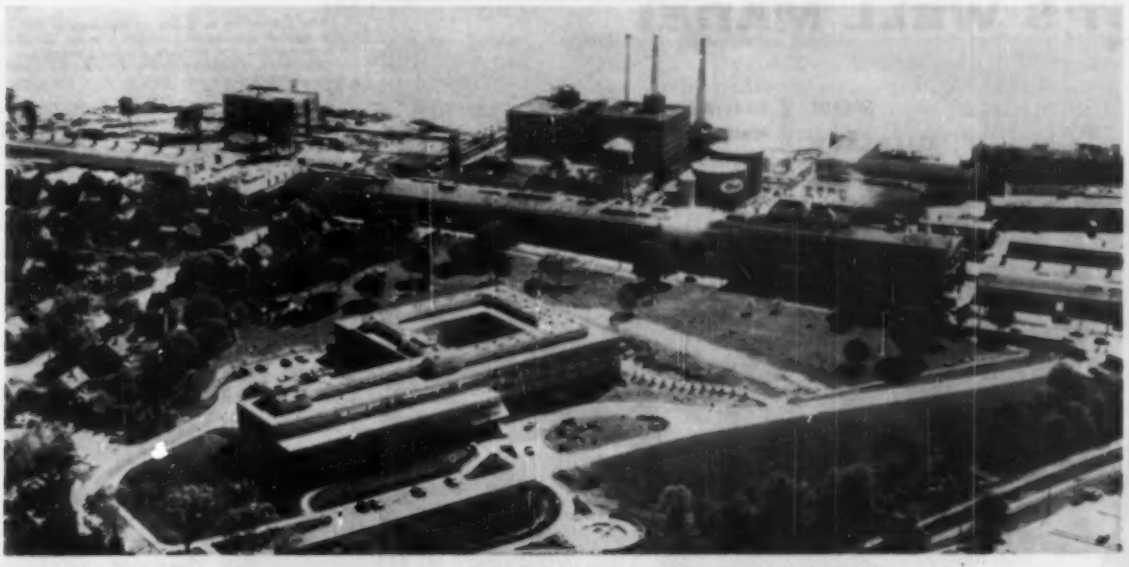
NEW ABRASION TESTER uses tungsten carbide blades to determine abrasion resistance of rubber at B. F. Goodrich Brecksville, Ohio, Research Center. New procedure closely correlates with actual performance.

EXPANDED FACILITIES at Liggett & Myers Tobacco Co.'s research laboratories in Durham, North Carolina, were formally dedicated at ceremonies last month. The labs, under the direction of Dr. Frederick R. Darkis, employ a total of 74 persons. A countercurrent distribution experiment is underway in this photo.

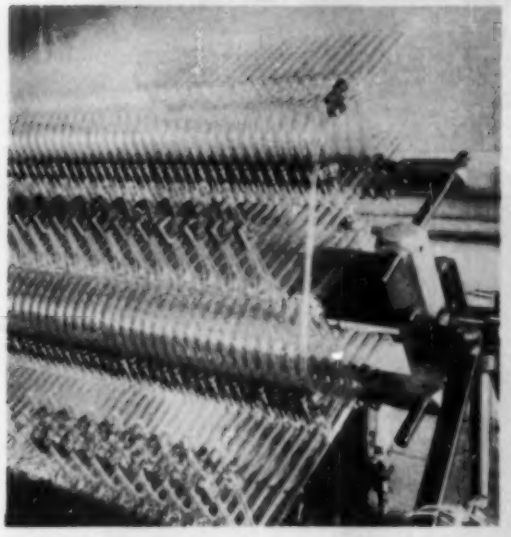
Photo—Courtesy Phillips Petroleum Co.

CHIEF McAFEE OF THE OSAGE. Jerry McAfee, A.I.Ch.E. prexy, accepts the resolution conferring tribal membership in the Osage Indian Tribe from Chief Paul Pitts as Councilman Eddie Red Eagle, Princess Beverly Wamego and Councilman D. E. Martin look on. Occasion was barbecue dinner at Woolaroc Ranch during 43rd National A.I.Ch.E. Meeting held in Tulsa, Oklahoma, this Fall.

cep camera



PFIZER CO.'S NEW RESEARCH LABORATORIES at Groton, Conn., were formally dedicated in ceremonies last month. Macrobiological, chemical and bio-chemical research units share the 177,000 sq. ft. structure located adjacent to the company's plant alongside the Thames river.



MODERN EQUIPMENT TO MATCH the modern technology of the hydrocarbon processing industries will be on display in New Orleans February 26-March 1 when the A.I.Ch.E. presents the 1961 Petrochemical and Refining Exposition and Conference to be held in conjunction with the 44th National Meeting. Exhibitors will hold forth in the Municipal Auditorium. For additional details write CEP.

A.I.Ch.E Candidates

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before December 15, 1960, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

Member

Adamson, G. A., *Pasadena, Calif.*

Boucher, H. G., *Normandy, Mo.*
Braude, G. L., *Baltimore, Md.*
Buchanan, B. B., *Bartlesville, Okla.*
Buck, F. A. M., *Wood River, Ill.*
Burger, D. C., *Texas City, Texas*

Christen, J. E., Jr., *Omaha, Nebr.*

Duval, C. A., Jr., *Beaumont, Texas*

Elgee, H. E., *Quebec, P. Q., Canada*

Graf, R. E., *Odessa, Fla.*
Grossmann, U. C., *Bartlesville, Okla.*

Harper, M. W., *Merchantville, N. J.*
Hull, F. B., *Bethlehem, Pa.*

John, G. S., *Notre Dame, Ind.*

Kittredge, P. H., *Trona, Calif.*

Leong, T., *Cucamonga, Calif.*

Ma, J. J. L., *West Chester, Pa.*
MacMillan, A. L., *Searsport, Me.*
Martin, A. W., *Corpus Christi, Texas*
McConnell, W. S., *Baton Rouge, La.*
McNally, W. A., *Wilmington, Del.*

Neidert, W. B., *Winnie, Texas*

O'Neill, J. H., Jr., *Circleville, Ohio*

Pigford, T. H., *Berkeley, Calif.*

Quinn, M. F., *Evergreen Park, Ill.*

Renda, J. D., *Baltimore, Md.*

Selm, R. P., *Salina, Kans.*
Sharpe, R. F., *Dayton, Ohio*
Strom, A. H., *Newport, Ind.*
Stukel, J. E., *Cleveland, Ohio*
Sturgeon, C. E., *Wichita, Kans.*

Westerman, R. G., *Detroit, Mich.*
Wilson, R. Q., *Columbus, Ohio*
Wimbish, C. O., *Kingsport, Tenn.*
Winneski, P. M., *Overland Park, Kans.*
Woodside, O. W., *Montreal, P. Q., Canada*

Yocum, B. T., *Borger, Texas*

Zoller, J. R., *Port Arthur, Texas*

Associate Member

Andrews, R. P., *Ferndale, Mich.*

Bailey, W. R., *New Lathrop, Mich.*
Bishop, R. P., *Indian Orchard, Mass.*
Bithel, L., *Two Hills, Alta., Canada*
Blatchley, W. C., *East Haven, Conn.*
Boberg, T. C., *Tulsa, Okla.*
Bogue, D. C., *Knoxville, Tenn.*
Boleng, P. L., *Muncie, Kans.*
Bornemann, G. A., *Freeport, Texas*
Bredeson, E. C., *Minneapolis, Minn.*
Bucksat, R. E., *Houston, Texas*
Bunnell, D. S., *Buena Park, Calif.*
Burval, J. T. *Charleston, W. Va.*
Byroade, G. A., *Fayetteville, Ark.*

Calhoun, J. C., *Los Angeles, Calif.*
Carlson, F. B., *Derby, Colo.*
Carney, R. W., *Bartlesville, Okla.*
Casals, J. C., *Melbourne, Victoria, Australia*
Christensen, R. I., *Decatur, Ala.*
Cobb, R. L., *Cyril, Okla.*
Coulson, E. W., Jr., *Webster Groves, Mo.*
Cour, T. H., *Austin, Texas*
Cross, E. A., *Groves, Texas*
Crumbling, H. A., Jr., *Baltimore, Md.*

continued on page 156

HOW CAUSTIC SODA IS KEPT IRON-FREE AT 285° F.

You are a producer of caustic soda faced with an unusual corrosion problem in which corrosive damage to equipment is not an important consideration: how can you economically protect your product from iron contamination from the steel tank cars that transport it?

This problem was faced by a leading chemical manufacturer. The solution: an 8-10 mil lining of sprayed HYPALON® synthetic rubber. Result: after more than three years of active service, the caustic soda still is kept iron-free. HYPALON has withstood 50% and 73% caustic soda shipped at temperatures as high as 285° F.—and the HYPALON lining has retained its original smooth finish.

HYPALON, Du Pont's synthetic rubber, is resistant to corrosive chemicals, abrasion, ozone, sunlight, weather, high temperatures (up to 350° F.). All this—plus its flame resistance and permanent colorability—makes it an extremely versatile elastomer.

For more information send for a copy of PROTECTIVE LININGS AND COATINGS, a brochure designed for the engineer with a corrosion problem. For your copy write: E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Department CEP-11, Wilmington 98, Delaware.

DU PONT SYNTHETIC RUBBER
NEOPRENE HYPALON® VITON® ADIPRENE®

Better Things for Better Living . . . *through Chemistry*

For more information, turn to Data Service card, circle No. 102

Candidates

from page 154

D'Ambrosio, B., *Stamford, Conn.*
Davis, J. H., *Columbus, Ohio*
Deavenport, E. W., Jr., *Kingsport, Tenn.*
DiPalma, J., *Norwalk, Conn.*
Dobbs, P. J., *Kettering, Ohio*
Dorsey, J. W., *Bishop, Texas*
Dove, W. T., *Norman, Okla.*
Duggan, R. B., *San Angelo, Texas*

Eiermann, J. H., *Indianapolis, Ind.*
Elliott, J. J., *Bethel Park, Pa.*
Ellis, C. E., *El Reno, Okla.*
Elmore, C. L., *Jacksonville, Fla.*
Epperly, A. D., *Bartlesville, Okla.*

Fasig, E. W., Jr., *Dayton, Ohio*
Feil, J. N., *Akron, Ohio*
Fethke, W. P., Jr., *Congers, N. Y.*
Fortman, R. J., *Ft. Detrick, Md.*
Fox, W. L., *West Point, N. Y.*

Gallicano, R. E., *New Rochelle, N. Y.*
Gallier, P. W., *Norman, Okla.*
Gigliotti, R. A., *North Adams, Mass.*
Ginnis, A. F., *Staten Island, N. Y.*
Gordon, C. A., *Sao Paulo, Brazil*
Grasfeder, F. L., *Union City, Tenn.*
Gray, P. A., Jr., *Corte Madera, Calif.*
Griffin, J. R., *W. Lafayette, Ind.*

Haaga, J. C., *Ossining, N. Y.*
Haney, W. A., *Richland, Wash.*
Harrold, W. C., *Pittsburgh, Pa.*
Heising, R. W., *Cedar Rapids, Iowa*
Hemphill, M. W., *Seaford, Del.*
Herbster, E. J., *Levittown, Pa.*
Hershey, H. C., *Alton, Ill.*
Hlaing, S., *Rangoon, Burma*
Holmes, P. W., *Baltimore, Md.*
Holsberg, L., *Wilmington, Del.*
Hood, R. C., *Dallas, Texas*
Horstman, R. F., *Rochester, N. Y.*
Houser, C. G., *Bartlesville, Okla.*
Hubinger, D. C., *Munster, Ind.*
Huff, N. F., *Midland, Mich.*
Humenick, M. J., *Richmond, Calif.*
Hunter, D. L., *Turtle Creek, Pa.*
Hurst, O. V., *Bartlesville, Okla.*
Hutchins, R. A., *Marshall, Texas*

Ince, H. C., Jr., *Cincinnati, Ohio*
Itoh, K., *Tokyo, Japan*

Jaumotte, J. A., *Baltimore, Md.*
Jernigan, E. C., *Houston, Texas*
Johnson, R. H., *Martin, Texas*

Kearns, C. H., *Oak Ridge, Tenn.*
Kenefick, E. V., *St. Paul, Minn.*
Kerrish, J. F., *Los Alamos, N. M.*
Kirk, C. L., *Pasadena, Texas*
Kitchen, M. R., *Midland, Mich.*
Kittrell, J. W., *Denver, Colo.*
Knott, J. F., *Cleveland, Ohio*
Knowlton, D. E., *Torrance, Calif.*
Kowler, R. A., *Bound Brook, N. J.*
Kunkel, H. E., Jr., *St. Albans, W. Va.*

Larcade, G. A., *Broken Bow, Okla.*
Leggett, L. W., Jr., *Baytown, Texas*
Li, S. C., *Bartlesville, Okla.*
Loban, R. D., *El Dorado, Kans.*
Louder, K. E., *Hampton, Va.*

McClintock, R. L., *Grosse Pointe, Mich.*
McConiga, R. E., *Argo, Ill.*
McCullough, R. D., *Aruba, Neth. Antilles*
McDowell, B. A., *Charleston, W. Va.*
Majoros, J. M., Jr., *Louisville, Ky.*
Martin, D. C., *Raleigh, N. C.*
Martin, K. W., *Port Huron, Mich.*
Matthews, G. A., *Bartlesville, Okla.*
May, D. S., *Baltimore, Md.*
Melli, P., *Metuchen, N. J.*
Menke, W. K., Jr., *Cambridge, Mass.*
Miller, D. G., *Borger, Texas*
Miller, J. A., Jr., *Whiting, Ind.*
Minges, M. L., *Dayton, Ohio*
Moore, B. H., *Spindale, N. C.*
Moore, N. E., *Kansas City, Kans.*
Mullarkey, J. R., *Wilmington, Del.*
Munro, B. L., *Borger, Texas*

Nelson, D. A., *Penns Grove, N. J.*
Nesser, J. J., *Bristow, Okla.*
Nichols, R. A., *E. Stroudsburg, Pa.*

Orent, H. H., *Rahway, N. J.*
Otake, N., *Tokyo, Japan*

Pe, M., *Rangoon, Burma*
Peterson, J. L., *Kingsville, Texas*
Piccirilli, J., *Mt. Vernon, N. Y.*
Pirkey, L. T., *Bartlesville, Okla.*

Ramachandran, P. S., *Boulder, Colo.*
Reti, A. R., *Cambridge, Mass.*

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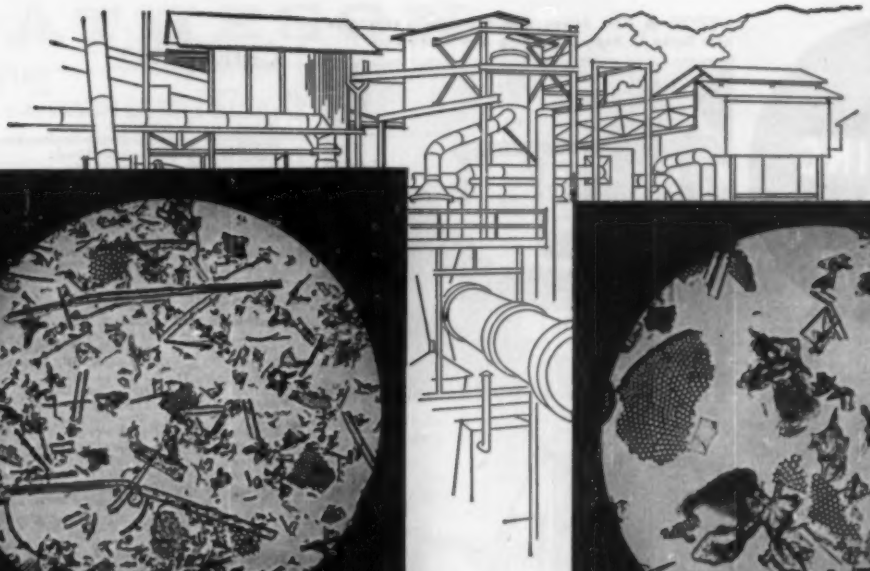
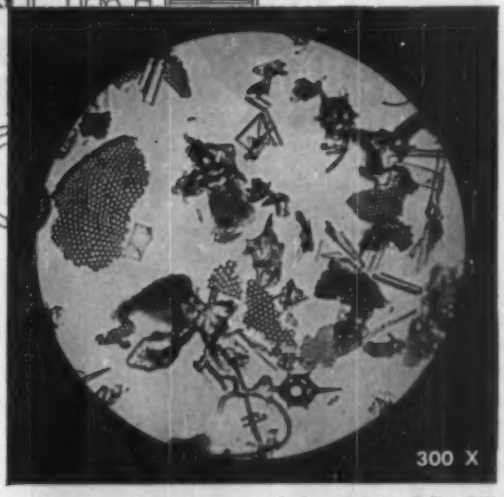


Milling and calcining equipment used for all Celite grades.

For high-clarity filtration of most liquids—use this specially milled diatomite, Hyflo Super Cel.

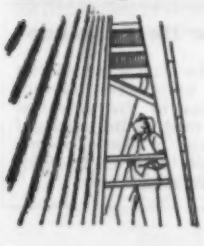


For filtration of larger suspended particles—Celite 545 combines maximum clarity plus faster flow rates.

In diatomites, Johns-Manville precision processing works for you

Constant uniformity in every grade of Celite assures consistent results, less down-time

For mineral filler use—Super Floss grade is made up of carefully sized fines air-floated off in the bag house.



Typical J-M bag house equipment.

As the microscope shows, each grade of Celite* diatomite has its own distinctive particle size distribution. Yet no matter where or when purchased, each remains uniform from bag to bag—your assurance of top production results with minimum down-time.

Three examples of flux-calcined Celites are shown here. Hyflo® Super Cel is widely used for filtration in many industries. It has just the right combination of coarse and fine particles to assure optimum clarity and flow rates. Celite 545, with a higher percentage of coarse particles, is used to achieve maximum clarity and faster flow rates with liquids that have larger suspended particles.

Super Floss, one of several bag house grades, has fine particle size distribution. A white powder, it is processed within very narrow tolerances (less than 1% retained on 325 mesh). It is a popular filler in fine products such as silver polishes.

Johns-Manville can precision-produce so many different grades of Celite because it mines the material from the world's largest and purest commercially available deposit. For assistance with specific filtration or mineral filler problems, talk to a nearby Celite engineer. Or write direct to Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ontario.

*Celite is Johns-Manville's registered trade mark for its diatomaceous silica products.

JOHNS-MANVILLE

For more information, turn to Data Service card, circle No. 39

Candidates

from page 156

Reynard, E. L., Jr., *Torrance, Calif.*
Robin, A., *Brooklyn, N. Y.*
Roedel, J. K., Jr., *Edwardsville, Ill.*
Root, D. F., *Longview, Wash.*
Rosen, E. M., *St. Louis, Mo.*
Roy, C. L., *Little Rock, Ark.*
Ryder, G. A., Jr., *Pittsburgh, Pa.*

Sanders, J. E., Jr., *Charleston, W. Va.*
Sanders, S. C., *Gary, Indiana*
Sauer, R. N., *Houston, Texas*
Schiller, J. P., *Corunna, Ont., Canada*
Schoeffel, D. E., *E. Longmeadow, Mass.*
Severson, D. J., *Park River, N. Dak.*
Sherk, F. T., *Bartlesville, Okla.*
Sherry, S. B., *Mathura, U. P., India*
Singh, T., *Cleveland, Ohio*
Sinibaldi, F. J., Jr., *Bound Brook, N. J.*
Smith, P. E., *Charleston, W. Va.*
Sobocinski, D. P., *Tulsa, Okla.*
Sproul, J. S., *Wilmington, Del.*
Startz, A. J., *Groves, Texas*
Steinberg, N. I., *Brooklyn, N. Y.*
Stuart, T. D., *Grand Forks, N. Dak.*
Sundblad, W. E., *Allentown, Pa.*
Svoboda, L., Jr., *Pine Bluff, Ark.*

Tolson, J. A., *Washington, D. C.*
Tucker, J. R., *Pasadena, Texas*

Uribe, J., *Medellin, Colombia*

Vidal, H. R., *Caracas, Venezuela*
Voit, J. E., *Philadelphia, Pa.*

Wadsworth, J. I., *New Orleans, La.*
Wallis, F., *Caracas, Venezuela*
Walsh, J. M., III, *New York, N. Y.*
Weiler, D. W., *Burt, N. Y.*
White, J. D., *Knoxville, Tenn.*
Wille, A., *Detroit, Mich.*
Williams, D. L., *West Palm Beach, Fla.*
Williams, F. S., *Belleville, Ill.*
Willis, R. D., *Hannibal, Mo.*
Winegardner, W. K., *Richland, Wash.*
Wohletz, R. F., *Las Vegas, Nevada*
Wood, J. D., *Birmingham, Ala.*
Woolley, M. J., *Cincinnati, Ohio*

Yen, L. C., *Austin, Texas*
Yuhas, S. A., Jr., *Perth Amboy, N. J.*

Ziegenhain, W. C., *Baytown, Texas*

Affiliate

Novak, J. C., *Lakewood, Ohio*
Smith, W. L., *Rancho Cordova, Calif.*

Union Carbide do Brasil will increase polyethylene production capacity from 9 to 24 million lb./year at its plant near Santos. Construction will start immediately, completion is scheduled for late 1961.

A new polymer plant at Orange, Texas, slated for completion by next January, will increase Firestone Tire & Rubber's production capacity for synthetic rubber by nearly 12%. The new unit will have an annual capacity of 30,000 tons of either Coral or Diene.

Nalco Chemical is expanding in two directions—is building a new manufacturing plant in Saltillo, Mexico, and is expanding the production facilities of its West German subsidiary, Deutsche Nalco-Chemie G.m.b.H.

Plan now for the Exposition

The first Petrochemical and Refining Exposition will bring new developments and ideas in the chemical and petroleum field to the National A.I.Ch.E. Meeting in New Orleans from February 26 to March 1, 1961. Make your reservations now.

MATHESON

Compressed Gas Notes

Gas Sterilization with Ethylene Oxide Mixtures

The science of sterilization has been changing over the past few years. Gone is the necessity of lengthy exposures to high heat to insure effective sterilization.

Heat and moisture-sensitive items, often ruined by long exposures to steam, can now be effectively and completely sterilized by the turn of a valve. The valve is on a cylinder of sterilizing gas called by different proprietary names, but consisting of Ethylene Oxide plus an inerting non-toxic, non-flammable gas to render the total mixture either non, or less flammable. For most sterilizing purposes, Ethylene Oxide concentrations of 450 to 1000 milligrams per liter of chamber space will be sufficient to provide a 100% kill.

Mixtures

The sterilizing mixture can be compounded in a number of ways to render the mixture more or less concentrated in Ethylene Oxide, or to have higher or lower cylinder pressure to suit the needs of the sterilizer function and design. The Matheson Compressed Gas Catalog lists sterilizing gas mixtures available from stock from all 3 Matheson plants. Special mixtures of any concentration of Ethylene Oxide are available from Matheson.

Fig. 1 illustrates the type of cylinder used to package sterilizing gas mixtures. The picture represents the sterilizing gas in two phases—liquid and gas. An eductor tube extends into the liquid phase of the mixture. When the cylinder valve is opened, the vapor pressure of the mixture forces the liquid out of the cylinder, through the eductor tube and valve. From there, the mixture may be piped directly to a sterilizer where the mixture will vaporize and do its job. Another method of dispensing the mixture to a sterilizer, is by first discharging the liquid into an expansion tank where it is allowed to completely vaporize. The mixture is then automatically fed from the expansion tank to the sterilizer as a completely mixed and vaporized gas, insuring a homogeneous mixture throughout the sterilizer.

Advantages

Here are some of the advantages gained by the use of gas sterilization:
Rapid action. All forms of organisms destroyed at ordinary temperatures. All types of substances and many packaging materials can be penetrated, allowing completely packaged items to be sterilized. (Even the pages of a closed book can be effectively sterilized.) Low toxicity to humans and animals. Can be rendered non-flammable. Convenient to handle. Easy storage. Gas completely removed by aeration; no residue. Non-corrosive.

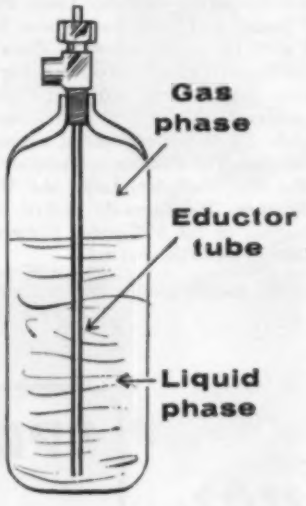


Fig. 1

Typical Applications

Here are a few of the items that have been effectively sterilized with sterilizing gas containing Ethylene Oxide: Plastic bandages, polyethylene bottles, packaged catheters, penicillin, surgical sutures, blankets, leather, wool, cotton, nylon, paper, plastics, foodstuffs, glassware, airplane cabins, railroad cars and buses.

We are equipped to supply sterilizing gases in regular or special formulations, in a variety of cylinder sizes. Our Sales Engineering Department will be glad to furnish further details and quotations concerning your needs. We will welcome your inquiries on gas sterilization.

Ethylene Oxide

In addition to sterilizing mixtures Matheson distributes Ethylene Oxide in quantities ranging from an 8 oz. Lecture Bottle to 400 lb. steel drums. Available from all three Matheson plants. Our Ethylene Oxide Bulletin gives Specifications and physical constants. Mail coupon for free copy.

Mail Coupon for Gas Catalog

Send for your free copy of the Matheson Compressed Gas Catalog containing prices and data on 82 compressed gases and gas mixtures available in 5 cylinder sizes and a complete line of gas regulating equipment.

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Firm_____
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Compressed Gases and Regulators East Rutherford, N. J. Joliet, Ill. Newark, Calif.

For more information, turn to Data Service card, circle No. 117

people in management and technology

C. T. Winchester transferred to Goodyear Tire & Rubber's new Beaumont, Texas, plant. He will be technical superintendent at the plant, starting January 1.

Lindsay I. Griffin has joined Esso Research and Engineering on a rotational assignment from the affiliated Esso Research Laboratories. Associated with Esso for 21 years, Griffin will be located at Linden, N.J.

Leonard H. Crudden has been appointed chief chemical engineer, Alcoa, Bauxite Refining Division. He moves up from the post of assistant chief chemical engineer for the division. Crudden has been with the company since 1922.

Joseph J. Raispis and **Jack W. Little** have been appointed to the Development and Service Department, Emery Industries. Raispis will provide service for the azelaic dimer and pelargonic acid lines of the company, as well as synthetic lubricant esters. Little will handle technical service for plastolein plasticizers and metholene fatty esters.

Harold G. Place has joined Ethyl Corp. as a development engineer, Research and Development Department. He received his BS and MS from Texas A.&M.

Raymond Ewell, vice chancellor for Research, University of Buffalo, has accepted an appointment as consultant to the government of India on the fertilizer industry. The appointment, under the auspices of the Ford Foundation, is for a period of four months. During this time, Ewell will work with the Ministry of Commerce and Industry and the Ministry of Food and Agriculture in formulating plans for expanding the fertilizer industry during the next five years. He will go by way of Rome, where he will stop off to confer with officials of the United Nations Food and Agriculture Organization and in Tehran, to confer with Iranian government officials. Ewell has conducted a number of studies of fertilizer requirements in the United States, India and the Philippines. He formerly served as consultant to the Philippine Government on industrial research.

John W. Biddle moves into the post of director of development at Union Carbide Chemicals. He has been in development activities at the South Charleston, West Virginia, Technical Center since joining the company in 1937.

Saul Gordon of Picatinny Arsenal has accepted an appointment as assistant professor in the Chemistry Department, Fairleigh-Dickinson University, Florham-Madison campus, Madison, N. J. He will continue his consulting affiliation at the Arsenal Pyrotechnics Lab, and his association with Gordon and Campbell, consulting chemists.

Norbert H. Kirchgessner has been appointed production superintendent, chemicals, at Hooker Chemical Durez Plastics Division's North Tonawanda, N.Y. plant. A Hooker employee since 1947, he was technical supervisor, plastics, until recently.

New chairman of the Chemical Engineering Department at Northwestern University Technological Institute is **George Thodos.** A faculty member since 1947, Thodos has published nearly fifty papers in his twenty year career, mostly on his specialty, petroleum technology. His current work is supported by grants from ACS Petroleum Research Fund, NSF, and

the Office of Scientific Research, U.S. Air Force. Thodos' doctoral dissertation, co-authored with O. A. Hougen, was one factor in winning Hougen the A.I.Ch.E. William Walker Award in 1944.

George D. Creelman has joined the senior professional staff of Richardson, Bellows, Henry & Co, consulting and research firm. Head of his own consulting firm, Creelman Associates, until recently, he was formerly research engineer with Monsanto, and director of research, M. A. Hanna Co.

Richard N. Williams takes over as director of administration, Squibb Division, Olin Mathieson Chemical. Williams, who joined the company in 1956, was director of administration and assistant to the general manager, Energy Division. He will be responsible for personnel, industrial relations, purchasing, public relations and transportation.

Dale U. von Rosenberg has been promoted to associate professor in the Chemical Engineering Department, Louisiana State U. He was, until 1957, with Humble Oil & Refining.

W. Metrailer has been named research associate at the Esso Research Laboratories, Baton Rouge, La. New additions to the technical staff at Baton Rouge are **E. N. Cart** and **A. H. Wehe, Jr.**

Eldon L. Hall has taken over the post of technical supervisor, Plastics Department, American Viscose, at Fredericksburg, Va. He was head of the Plastic Laboratory, Research and Development Department, Marcus Hook, Pa.

Administrative appointments in the Standard Oil (Indiana) Research and Development Department are **Morris T. Carpenter** (left) and **Thomas G. Stack**, assistant directors of administration, Whiting, Indiana, laboratories. **Donald G. Schroeter** replaces Stack as superintendent of employee relations. Carpenter joined the company in 1930. Recently, he has held several supervisory positions in Whiting and Chicago.

In further consolidation of Standard

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people

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Oil of California's industrial and agricultural chemical activities into one subsidiary, California Chemical Co., **J. Q. Cope** has been appointed vice president and manager of facilities and negotiations. **W. H. Schiffler** is vice president and manager, planning and development.

Milton Freifeld has joined the technical staff of General Aniline & Film Central Research Laboratory. His offices are in Easton, Pennsylvania.

R. B. Bird will teach one of seven graduate level courses being presented in the 1960-61 Humble Lectures in Science and Engineering Program at the Baytown, Texas, refinery of the company. Bird, who is a member of the University of Wisconsin's Chemical Engineering Department, will present a course in Transport Phenomena. The last course in the series will be taught by **R. E. Treybal** of New York University's Chemical Engineering Department. The course is on Solvent Extraction.

Henry B. Linford has been selected by the Electrochemical Society to receive its Edward Acheson Gold Medal and $1,000 prize for this year. Linford, professor of Chemical Engineering at Columbia University, has been a member of the Society since 1936, and is president of the organization for 1961-62. The Medal is awarded for conspicuous contributions to advancement of the purposes and activities of the society. Presentation took place at the fall meeting in October, in Houston, Texas.

Elmer L. Gaden, Jr. has been appointed chairman of the Department of Chemical Engineering at Columbia. Gaden was one of the ACS sponsored lecturers at the recent International Fermentation Symposium in Rome. He recently visited the National University of Mexico to give a series of lectures on fermentation and biochemical engineering in the School of Chemistry. He also addressed the Third National Congress of Microbiology.

continued on next page

people

continued

Thomas A. Marshall, Jr. has been elected executive secretary of the American Society for Testing Materials. He leaves his post as senior assistant secretary of ASME to take over his new responsibilities. These include heading the staff for the 10,000 member society. **Fred F. Van Atta** has been elected treasurer of ASTM. The John Fritz Medal for 1961 has been awarded to **Stephen D. Bechtel.** The Medal is awarded for notable scientific or industrial achievement in the engineering profession. Bechtel, president of Bechtel Corp., has been associated with the company bearing his name for 42 years. He is a member of ASCE, the organization which made the formal presentation. Choice of Bechtel as winner was made by the John Fritz Medal Board of Award which consists of five societies, including A.I.Ch.E.

Russell E. Van Steenburgh has been appointed area supervisor, diisocyanates, at Allied Chemical's National Aniline Plant, Moundsville, Va. Van Steenburgh joined National Aniline in 1952, as a member of the Engineering Department. Most recently he was area maintenance supervisor of Plant A in Buffalo, N.Y.

A. J. Johnson takes over the post of vice president, Shell Development's head office in New York City. He is now vice president, Development and Engineering Division, of the company's Emeryville, California, Research Center.

R. Donald Stafford has been named senior project evaluator, B. F. Goodrich Chemical, Cleveland. He will assist in development of project evaluation techniques and integration of plans for product development programs. Stafford, who joined the company in 1942, was senior development scientist.

Richard E. Schuman has been appointed manager of operations and planning in the research division, A. E. Staley Manufacturing. Formerly technical service administrator, Schuman joined the firm in 1951 as a chemical engineer. His new post will include duties in financial and organization planning, and administering

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People

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service functions at the company's new research center.

Marketing

George J. Sella, Jr. has been appointed sales manager, American Cyanamid Rubber Chemicals Department. His office will be in Bound Brook, N. J. Sella has served the company in various capacities since 1954, in the engineering, process development and production sections.

Donald G. Grew moves into the post of process sales engineer, Beckman Instruments, Scientific and Process Instruments Division. He will handle the northwest section with territory taking in Washington, Oregon, Idaho, Montana, and Alaska and British Columbia, Alberta and Saskatchewan.

C. D. Schroeder has been promoted to assistant district manager at Dearborn Chemical. He will assist **E. W. Houseknecht** in the Illinois-Wisconsin District.

Necrology

C. E. Kenneth Mees, 78, retired vice president for research, Eastman Kodak. Mees organized the Kodak Research Laboratories in Rochester, New York, in 1912 at the request of George Eastman, founder of the company. He retired in 1955 after holding a series of executive offices with Eastman. The author of about 150 publications, Mees also published several books. He was internationally known as an authority on color photography progresses, and for his work in photographic science.

Roy G. Hemminghaus, 52, vice president, new product planning, Chemstrand. During his ten year career at Chemstrand, Hemminghaus served as vice president and general manager of manufacturing, and as vice president, staff services, as well as . other executive capacities.

Nylon filament yarns will be produced in Mexico by a new company just formed by Chemstrand Overseas in conjunction with Julio Gonzalez Mora. Production facilities will be located near Mexico City, start-up is scheduled for mid-1961.

A major expanion will double facilities at the Syracuse, New York, research-technical service laboratory of Allied Chemical's Solvay Process Division.

Ground has been broken by Archer-Daniels-Midland for a new multi-million dollar chemical center at Peoria, Illinois. The new plant, to go on stream early in 1962, will produce chemicals "new to ADM," as well as the company's established line—nitrogen compounds, plasticizers, esters, olefins, chemical intermediates.

Catalytic Construction has been selected to perform the maintenance on Hercules Powder's new polypropylene plant now nearing completion at Lake Charles, Louisiana.

In its diversification program, Dresser Industries has purchased Podbielniak, Inc. This Chicago-based company manufactures centrifugal solvent extractors, laboratory fractional distillation apparatus, and packaged distillation plants. Podbielniak will function under the same management as a part of the Dresser group of companies.

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local sections

More officers for coming year

North Alabama Section

Chairman	C. J. Setzer
Vice chairman	E. M. Milner
	W. H. Libby
	W. C. Scott
Secretary	R. J. Jaskot
Treasurer	J. W. Parrott

North Jersey Section

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Vice chairman	R. Cohen
Secretary	P. Napoli
Treasurer	M. Smith

Northeastern New York Section

Chairman	J. D. Snyder
Vice Chairman	M. Kirk
Secretary	K. M. Kiser
Treasurer	D. M. Lewis

Northern California Section

Chairman	J. F. Valle-Riestra
Vice chairman	R. C. Phillips
Secretary	R. T. Milligan
Treasurer	E. M. Blue

Northern West Virginia Section

Chairman	J. E. Fraker
Vice chairman	E. H. Ten Eyck
Secretary	P. Thistleton
Treasurer	R. J. Scott

Ohio Valley Section

Chairman	L. Rogovin
Vice chairman	G. Kutzko
Secretary	K. R. Ericson
Treasurer	G. D. Moon, Jr.

Peninsular Florida Section

Chairman	C. E. Huckaba
Vice chairman	F. A. O'Neall
Secretary-Treas.	F. P. May

Pensacola Section

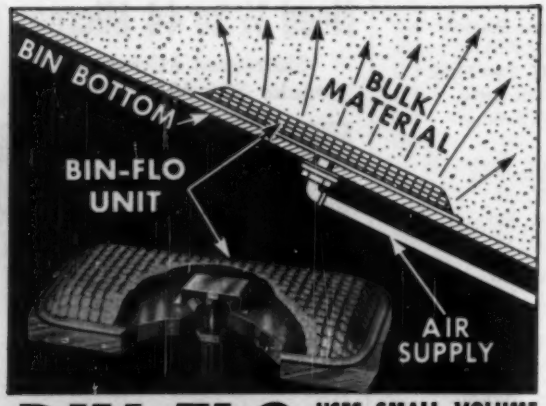
Chairman	J. B. McKoy
Vice chairman	S. Ruden
Secretary	W. E. Eisele
Treasurer	L. S. Campbell

Philadelphia-Wilmington Section (now Delaware Valley Section)

Chairman	R. R. Halik
Vice chairman	F. J. Gradishar
Treasurer	J. E. Ross
Asst. Treas.	C. H. Collier
Secretary	R. Fleming
	W. J. Borns

Pittsburgh Section

Chairman	E. O. Ohsol
Vice chairman	V. N. Hurd
Secretary	G. J. Haddad
Treasurer	J. H. Black



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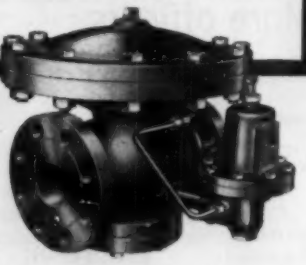

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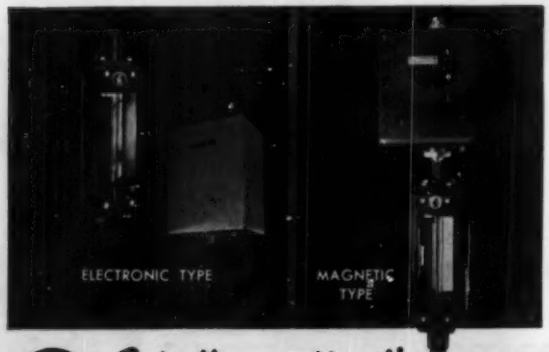

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local sections

New York Section one-day meeting, Colton honored

SYMPOSIUM SUBJECTS at the recent one-day meeting of A.I.Ch.E.'s New York Section ranged from new and unusual sources of electric energy to a review of the various facets of a career in chemical engineering.

The two-session symposium on *Unconventional Sources of Electrical Energy* (J. D. Heldman, Shell Oil, presiding) got off to a start with a talk by R. W. Pidd of General Dynamics on *Thermionic Generation of Electricity*. Heat transfer considerations were emphasized in the following talk on *Thermoelectricity* by R. L. Petritz of Texas Instruments. Theoretical operating efficiencies, losses, and output characteristics of *Solar Cell Power Systems* were discussed in detail by R. L. Sohn, Space Technology Laboratories. The morning session wound up with a talk by T. R. Brogan of Avco-Everett Research Laboratory on *Magnetohydrodynamic Power Generators and Their Application*. After lunch, the symposium fin-

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J. W. Colton (right), retiring chairman of the New York Section, is presented with certificate of appreciation by Jerry McAfee, A.I.Ch.E. president.

local sections

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ished with three further discussions of things to come—*The Fuel Cell: Its Promise and Problems*, by W. J. Sweeney of Esso Research and Engineering, *The Role of Nuclear Energy in Conventional and Unconventional Power Generation*, by B. I. Spinrad, ANL., and *A View of the Investment Significance and/or the Commercial Future*, by D. Samuel of The Energy Fund.

What is a chemical engineer?

A second all-day symposium, under the gavel of E. Boe of Arabian American Oil, dissected *The Anatomy of a Profession*. J. G. Devys, Etude et Realisation de Projets Industriels, Paris, France, led off the session with a discussion of *The Chemical Engineer in Europe*, with particular emphasis on the role of the American chemical engineer abroad. Planned development of the engineer within industry was the keynote of a discussion by A. J. St. Louis of Food Machinery and Chemical on *Engineering the Engineer's Future*. "Engineers are particularly fitted by training and temperament for many kinds of 'non-engineering' activities," said J. F. Dudley of Commercial Solvents, in the course of his talk on *The Engineer in Public Life*. A. W. Fleer (Shell Chemical) concluded the morning session with a talk on *The Chemical Engineer: A Ratiocination*, a consideration of many aspects of a professional life. An unusual talk on *How to Plan and Write a Technical Book*, given by T. G. Hicks of McGraw-Hill Book Company, constituted the afternoon part of the symposium.

A third symposium, presided over by G. Forlenza of American Cyanamid, comprised four more technical papers grouped under the heading of *New Developments in Chemical Engineering: A Review of Urea Synthesis Processes* (L. H. Cook, Chemical Construction Corp.); *Design of Non-Isothermal Fixed Bed Catalytic Reactors* (R. S. Davis, Scientific Design); *Process Simulation with the Analog Computer* (G. R. Marr, Jr., Columbia Univ.); and *Characterization of Heat and Mass Transfer Equipment* (I. H. Rinard, American Cyanamid).

Special award

Luncheon speaker at the all-day affair in the New Yorker Hotel was Jerry McAfee, A.I.Ch.E.'s president, who took the occasion to present to

John W. Colton of Scientific Design a certificate in appreciation of his outstanding services as Chairman of the New York Section for 1959-1960.

Western Massachusetts Section *(D. F. Doonan)* featured a talk by John J. Healy, vice president of A.I.Ch.E. and member of Monsanto's Corporate Planning Board. He spoke on A.I.Ch.E. activities . . . A tour of the Republic Steel Company plant in Buffalo was highlight of the **Western New York Section** *(R. L. Shaner)* . . . The newly chartered **Mid-Hudson Section** *(Louis E. Ruidisch)* held its first meeting of the 1960-61 season. L. C. Kemp, Jr. presented the charter. Formal ceremonies preceded the meeting . . . Clement J. Freund spent two years in Pakistan, 1958-60, as consultant to the Pakistani government on engineering and higher technical education. Freund, dean of the College of Engineering, University of Detroit, told the **Detroit Section** *(H. W. Grubb)* about his experiences there . . . Annual picnic of the **South Texas Section** *(G. H. Cummings)* was hosted by the **Brazoport Sub-Section** . . . Nuclear radiation hazards and their engineering aspects was the topic at the **Southern California Section** *(H. W. Kellar)*. Speaker was Jack Jacobson, superintendent of field operations, Atomics International . . .

Computers and land

Chemical engineers are taking the lead in finding many uses for computers, the **Bartlesville Section** was told. B. A. Friedman, regional manager, Computer Analyst Department, Royal McBee Corp., defined small computers in research and development uses. A machine the size of an office desk, renting for $1,000 to $2,000 a month costs about $100,000. Universities, he said, are insisting more and more on computer courses for engineers, and computers are rapidly becoming a common tool . . . **North Jersey Section** *(S. A. Savitt)* devoted the October meeting to discussion of a recent study on area land reclamation. Speaker was Joseph M. De Salvo, vice president and chief engineer, Joseph S. Ward consulting firm . . . Electrokinetics and electrostatics and some aspects of interest to chemical engineers occupied the **Fairfield County Section** *(L. Chirgwin)* in September. Guest speaker was Jerome Gavis, assistant professor of chemical engineering, John Hopkins University.

future meetings

1960—MEETINGS—A.I.Ch.E.

● **WASHINGTON, D. C. Dec. 4-7, 1960. Statler Hotel. A.I.Ch.E. Annual Meeting.** See page 128.

1960—MEETINGS—Non-A.I.Ch.E.

● **WASHINGTON, D. C. Dec. 12-14, 1960. National Conf. on Water Pollution.** For info: R. S. Hutchings, Room 4310, HEW Bldg. South., Wash. 25, D. C.

● **PITTSBURGH, PA. June 28-30, 1961. Univ. Colo. campus. Second Joint Automatic Control Conference.** Sponsored jointly by ISA, A.I.Ch. E., AIEE, ASME & IRE. Brief abstracts & rough draft of entire paper required before end of 1960. A.I.Ch.E. Prog. Chmn.: N. Gilbert, Ch.E. Dept., Univ. Cincinnati, Cincinnati 21, Ohio.

1961—MEETINGS—A.I.Ch.E.

● **NEW ORLEANS, LA. Feb. 26-Mar. 1, 1961. Hotel Roosevelt. A.I.Ch.E. National Meeting.** Gen. Arr. Chmn.: O. F. Wiedeman, Cyanamid, New Orleans, La. & H. E. O'Connell, Ethyl Corp., Baton Rouge, La. Tech. Pro. Chmn.: A. L. Regnier, Cities Service R&D Co., 70 Pine St., New York 5, N. Y.

Free Forum-Informal Discussions of Possible Future Developments and New Research Areas—M. S. Peters, Univ. Ill., Urbana, Ill.

Brainstorming Technical Problems—G. C. Szego, Space Technology Labs., P. O. Box 95001, Los Angeles 45, Calif.

Kinetics of Catalytic Reactions—M. Boudart, Princeton U., Princeton, N. J.

Petrochemicals—Future of the Industry on the Gulf Coast—J. A. Sherred, Monsanto Chem. Co., St. Louis 66, Mo.

Filtration—F. M. Tiller, U. of Houston, Houston, Texas.

Settling—A. G. Keller, La. State U., Baton Rouge, La.

Future Processing Technology in the Petroleum Industry—A. F. Kaulakis, Process Res. Div., ESSO, Baton Rouge, La.

Education and Professionalism—R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, Ohio.

Mathematics in Chemical Engineering—R. L. McIntire, Mathematical Eng. Assoc., 3108 Sweetbriar, Fort Worth 9, Texas.

Evaluation of R & D Projects—L. A. Nicolai, 239 Parsonage Hill Rd., Short Hills, N. J.

Liquid-Liquid Extraction—R. B. Beckmann, Carnegie Tech., Pittsburgh 13, Pa.

New Petrochemical Processes in the Area—B. G. Caldwell, Dow Chem. Co., Plaquemine, La.

Materials of Construction—R. V. Jelinek, Syracuse U., Syracuse, N. Y.

Thermodynamics—J. J. Martin, Ch.E. Dept., Univ. Calif., L. A. 24, Calif.

Use of Probability Mathematics in Economic Evaluation—A. G. Bates, Atlas Powder Co., New Murphy Rd., Wilmington 99, Del.

International Chemical Industry—L. Reser, CEP.

New Chemical Processes—B. G. Caldwell, Dow Chem. Co., Plaquemine, La.

Selected papers—E. Mannings, Shell Oil Co., Norco, La.

● **CLEVELAND, O. May 7-10, 1961. Hotel Sheraton, Cleveland. Joint A.I.Ch.E. National Meeting with Ch.E.Div. C.I.C.** Gen. Arr. Chmn: H. Pforsheimer, Jr., Standard Oil Co. (Ohio), Cleveland, O. Canadian Gen. Arr. Chmn.: W. D. Gauvin, McGill Univ., Montreal, Que. Tech. Prog. Chmn.: R. P. Dinsmore, Goodyear Tire & Rubber Co., Akron 16, O. Canadian Tech. Prog. Chmn.: A. I. Johnson, Toronto Univ.

DEADLINE FOR PAPERS: Dec. 7, 1960.

Petrochemicals as Starting Materials for Polymers—L. F. Marek, A. D. Little, 30 Memorial Dr., Cambridge 42, Mass.

Fluid Mechanics—W. H. Gauvin, McGill Univ., Montreal, Que.

Laboratory and Pilot Plant Techniques—J. T. Cumming, School Eng., Penn College, Cleveland 15, O.

Process Dynamics (Theoretical)—R. M. Butler, Imperial Oil Co., Sarnia, Ont.

Synthesis Processes for Isoprene—T. A. Burtis, Houdry Process Corp., 1528 Walnut St., Phila. 2, Pa.

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future meetings

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Radioactive Materials for Process Control—J. R. Bradford, College of Eng., Texas Tech. College, Lubbock, Tex.

Process Dynamics (Applied)—L. M. Naphtali, Ch.E. Dept., Brooklyn Polytech., Brooklyn, N. Y.

New Synthetic Rubber Types—P. M. Lindstedt, Goodyear Tire & Rubber Co., Ch.E. Div., Akron 16, O.

Coalescence—R. Kintner, Illinois Inst. Tech., Chicago 16, Ill.

Management Criteria for Capital Investment—C. F. Prutton, Food Machy. & Chem. Co., 161 E. 42d St., New York, N. Y.

Chemical Engineering in Metal Refining—W. M. Campbell, Chem. & Met. Div., Atomic Energy of Can., Chalk River, Ont.

Heavy Chemical Mfr.—L. P. Scoville, Diamond Alkali, Union Commerce Bldg., Cleveland 14, O.

Applications of High Speed Photography—A. I. Johnson, Univ. of Toronto, Toronto 5, Ont.

Pulp and Paper—J. L. McCarthy, Univ. Washington, Seattle 5, Wash.

New Research Techniques—D. Hyman, Cyanamid, 1937 W. Main St., Stamford, Conn.

Mixing-Fundamentals—J. Y. Oldshue, Mixing Equipment Co., P. O. Box 1370, Rochester, N. Y.

Mixing-Applications—E. E. Ludwig, Rexall Chem. Co., 8909 West Olympic Blvd., Beverly Hills, Cal.

Cash Flow Methods in Economic Analysis—D. D. MacLaren, Esso Research & Eng., P. O. Box 215, Linden, N. J.

Heat Transfer—E. H. Young, Univ. Mich., Ann Arbor, Mich.

Selected Papers—D. J. Porter, Diamond Alkali, P. O. Box 348, Rsch. Center, Painsville, O.

Student Program—H. B. Kendall, Case Inst., 10900 Euclid Ave., Cleveland, O.

• LAKE PLACID, N. Y. Sept. 24-27, 1961.

Lake Placid Club. **A.I.Ch.E. National Meeting.** Gen. Arr. Chmn.: B. I. MacDonald, Jr., G. E. Co., Waterford, N. Y. Tech. Prog. Chmn.: E. R. Smoley, 30 School Lane, Scarsdale, N. Y.

DEADLINE FOR PAPERS: Apr. 24, 1961.

Control of Corporate Capital Investment Costs—W. K. Manke, Pittsburgh Chem. Co., Grant Bldg., Pittsburgh 19, Pa.

Management of Wastes at Nuclear Power Stations—W. F. Swanton, Pfaudler Co., Rochester, N. Y.

World-Wide Sales Challenges in the 60's in the CPI—J. T. Costigan, Sharples Corp., 501 Fifth Ave., N. Y. 17, N. Y.

Mechanisms of Chemical Reactions—J. T. Horeczy, Humble Oil, P. O. Box 3950, Baytown, Tex.

Foamed Organic Materials—M. I. Nadler, Du Pont, P. O. Box 232, Penns Grove, N. J.

Chem. Engrg. in the Photographic Industry—A. K. Ackoff, Eastman Kodak, Kodak Park Works, Rochester 4, N. Y.

Techniques to Improve Profitability of Petrochemical Processes—G. E. Hayes, Phillips Petro. Co., Bartlesville, Okla.

Economics Theories Applied to Growth Industries—No Chmn.

Petrochemicals in the 60's—No Chmn.

Market Development in the CPI—L. B. Hitchcock, 60 E. 42 St., N. Y. 17, N. Y.

Bulk Fibrous Materials—R. M. Christiansen, Stearns-Roger Mfg. Co., Denver, Colo.

Economics of Equipment Selection—E. E. Ludwig, Rexall Chem. Co., 8909 West Olympic Blvd., Beverly Hills, Cal.

Selected Papers—No Chmn.

• NEW YORK, N.Y. Dec. 3-6, 1961. Hotel Commodore. **A.I.Ch.E. Annual Meeting.** Gen. Arr. Chmn.: L. J. Coulthrust, Foster Wheeler Corp., 666 Fifth Ave., N.Y. 19, N.Y. Tech. Prog. Chmn.: A. V. Caselli, Shell Chem. Corp. 50 W. 50 St., N.Y. 20 N.Y.

DEADLINE FOR PAPERS: July 3, 1961.

Fluidization—F. A. Zenz, Assoc. Nucleonics, Inc., 975 Stewart Ave., Garden City, N. Y.

International Chemical Industry—No Chmn.

U. S. Chemical Industry—No Chmn.

Utilization of Technical Personnel—No Chmn.

High Viscosity Fluids-Design Aspects—No Chmn.

Physical and Transport Properties—No Chmn.

Polymerization Kinetics and Catalyst Systems—No Chmn.
Heterogeneous Catalysis and Chemisorption—No Chmn.
Heat Transfer-Phase and Chemical Change Systems—G. T. Skaperdas, M. W. Kellogg, 711 Third Ave., N. Y. 17, N. Y.
Solid State Principles—No Chmn.
Flame Theory and Plasmas—H. M. Hulbert, Am. Cyanamid, 1937 West Main St., Stamford, Conn.
Solid State Applications—No Chmn.
Water Pollution—No Chmn.
Petroleum Processes—No Chmn.
Petrochemical Processes—No Chmn.
Hydrometallurgy—G. H. Beyer, Univ. of Mo., Columbia, Mo.
Volatility Processing for Spent Reactor Fuels—No Chmn.
Recent Advances in Ferrous Pyrometallurgy—S. V. Margolin, A. D. Little, Inc., Acorn Park, Cambridge, Mass.
Rationale of Pilot Plants—J. T. Cumming, Penn College, Cleveland 5, O. & G. W. Blum, 184 Ernest Dr., Tallmadge, O.
Polymer Handling Equipment—No Chmn.
Process Dynamics, Control, and Simulation—A. S. Foss, Eng. Exp. Sta., DuPont, Wilmington 98, Del. & D. E. Lamb, Univ. of Del., Newark, Del.
Radiation and Furnace Design—No Chmn.
Selected Papers—C. M. Thatcher, Pratt Inst., 215 Ryerson St., Brooklyn, N. Y.
Student Program—R. O. Parker, N. Y. U. University Hghts, N. Y.

1962—MEETINGS—A.I.Ch.E.

• LOS ANGELES CAL. Feb. 4-7 1962. Hotel Statler. **A.I.Ch.E. National Meeting.** Gen. Arr. Chmn.: B. B. Kuist, Fluor Corp., P. O. Box 7030, Los Angeles 22. Cal. Tech. Prog. Chmn.: O. C. Szego, Space Technology Labs, P. O. Box 95001, Los Angeles 45, Cal.

DEADLINE FOR PAPERS: Sept. 4, 1961.

The Ch.E. as a Citizen, Engineering the Defense Dollar—O. C. Szego. Address above.
Air Pollution—W. L. Faith, Air Pollution Foundation, 2356 Mission St., San Marino, Cal.
Air Pollution (Evening Panel)—A. J. Teller, Colonial Iron Works, Cleveland, Ohio.
Ch.E. in the Food & Biological Ind.—J. C. Harper, Univ. of Cal., Davis, Cal.
Ch.E. Aspects of Space Flight—A. E. Humphrey, Univ. of Pa., Philadelphia 4, Pa.
Ch.E. Aspects in Space Nutrition—J. J. Konikoff, M.S.V.D., G.E. Co., D & Luzern Sts., Philadelphia 4, Pa.
Competitive Nuclear Power—R. B. Richards, A.P.E.D., G.E. Co., San Jose, Cal.
Heat Transfer in Rocket Nozzles—R. S. Levine, Rocketdyne, 6633 Canoga Ave., Canoga Park, Cal.
Petroleum Production—No Chmn.
Hydrogen Cracking—No Chmn.
Elastomer Technology—E. G. Partridge, 3551 University Ave., U. S. C., Los Angeles, Cal.
Education and Humanities—No Chmn.
Plastic Materials Under Extreme Conditions—K. N. Lemons.
Important Ch.E. Problems of the Future—R. S. Schecter, Univ. of Texas, Austin, Tex.
Drying-Fundamentals—R. E. Peck, Ill. Inst. Tech., Chicago 16, Ill.
Drying-Equipment—F. H. Stratman, Gen. Am. Transport. Co., 135 So. LaSalle St., Chicago 90, Ill.
Fluids—No Chmn.
Mathematical Optimization Techniques in Ch.E.—G.J. Hsieh, Un. Carbide Corp., 30 E. 42 St., N. Y. 17, N. Y.
New Techniques in the Recovery of Chemicals from Saline Deposits—D. E. Garrett, Assoc. Chemicals, Box 447, Pomona, Cal.
The Chemical Engineer and the Law—R. W. Schramm, So. Nitrogen Co., 485 Lexington Ave., N. Y. 17, N. Y.
Ion Exchange—M. M. David, Univ. of Wash., Seattle 5, Wash.
Cost Reduction in New Plant Construction—No Chmn.
New Advances in Water Desalination—F. J. Lockhart, U. S. C., 3551 University Ave., Los Angeles 7, Cal.
Selected Papers—No Chmn.
Student Program—W. H. Corcoran, Cal. Tech., Pasadena, Cal.

• BALTIMORE, MD. May 20-23, 1962. Lord Baltimore Hotel. **A.I.Ch.E. National Meeting.**

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future meetings

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Gen. Arr. Chmn.: B. L. Harris, Chem. Welfare Labs., Army Chem. Cent., Md. Tech. Prog. Chmn.: G. L. Bridger, Washington Rsch. Center, W. R. Grace, Clarkesville, Md.

Equipment Instrumentation—No Chmn.
Low Temperature—No Chmn.
Fertilizers—No Chmn.
Pesticides—No Chmn.
Chemical and Physical Effects of Radiation—P. W. Lampe, Humble Oil, Baytown, Tex.
Organometallic Compounds—H. A. Holcomb, Humble Oil, Baytown, Tex.
Unit Processes—No Chmn.
Combustion and Aerthermo Chemistry—No Chmn.
Behavior of Matter in Suspension in Gases—No Chmn.

• DENVER, COLO. Aug. 26-29, 1962. Hilton Hotel. **A.I.Ch.E. National Meeting.** Gen. Arr. Chmn.: B. E. Lauer, Univ. of Colo., Boulder, Colo. Tech. Prog. Chmn.: F. H. Poettmann, Ohio Oil Co., P. O. Box 269, Littleton, Colo.

• CHICAGO, ILL. Dec. 2-5, 1962. Conrad Hilton Hotel. **A.I.Ch.E. Annual Meeting.** Gen. Arr. Chmn.: G. E. Ballie, Visking Co., 6733 W. 65 St., Chicago 38, Ill. Tech. Prog. Chmn.: A. L. Conn, Standard Oil Co. (Ind.) 2400 N.Y. Ave., Whiting, Ind.

Unscheduled Symposia

Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.

Computers in Optimum Design of Process Equipment: Chen-Jung Huang, Dept. of Chem. Eng., Univ. of Houston, Cullen Blvd., Houston 4, Texas.

Solar Energy Research: J. A. Duffie, Director of Solar Energy Laboratory, Univ of Wisconsin, Madison, Wis.

Michigan Chemical has acquired the South Charleston, West Va., anhydrous hydrogen bromide facilities formerly owned and operated by Food Machinery and Chemical's Westvaco Chlor-Alkali Division. The facilities have been moved to Michigan's Saint Louis plant.

In one more step in a planned expansion program, Pfaudler Permutit has acquired AeroChem Research Laboratories, Inc. Current projects at the Princeton, N.J. basic research firm are working on the burning mechanism of solid propellants, advance propulsion schemes, and the effect of combustion on heat transfer. AeroChem will continue to operate under its same management.

A 10 million pounds a year combination unit for producing polyester and alkyd resins is planned by Reichhold Chemicals. The company's Jacksonville, Fla., plant expansion will serve the southeast part of the U.S.

Time is growing short

The Petrochemical and Refining Exposition to be held in conjunction with the National A.I.Ch.E. Meeting in New Orleans, Feb. 26-Mar. 1, 1961. The theme will be the Chemical Engineer's role in design and development of petroleum and petrochemical facilities.

now available . . . . A.I.Ch.E.'s second Computer Program Manual

. . . describes a program that essentially will completely design, including sizing the nozzles, a shell-and-tube heat exchanger or cooler, with liquid on both the shell and tube sides. It can also be used to calculate the pressure drops and over-all coefficient in checking an existing exchanger for a new service. The program uses standard methods.

The program listing is given for a basic IBM 650 computer; however the complete description of the calculation procedure and the logic diagram included will facilitate its translation for use on other computers

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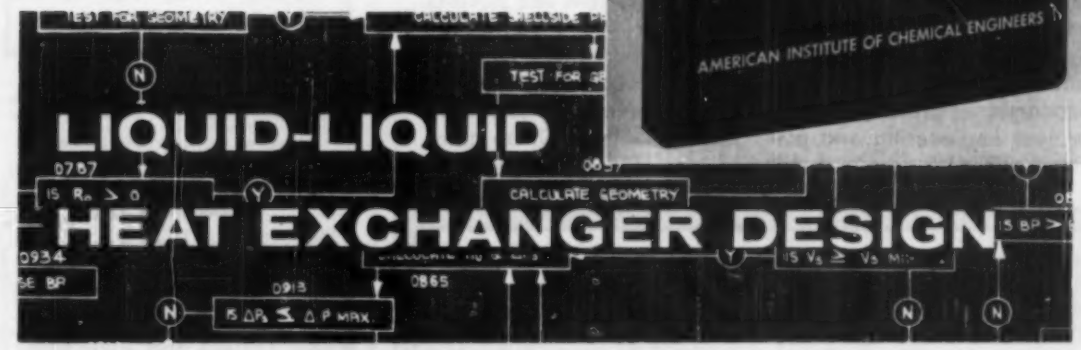

CONTENTS

- Description of program
- Diagrammatic flow chart
- Program details and operation
- Notation
- Literature cited
- Deck listing
- Sample problem—new exchanger
- Sample problem—existing exchanger
- Process engineering interpretive coding system

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CHEMICAL ENGINEER—Experience in Process Design and Development. Strong Technical background, advanced degree. Organized and directed up to twenty technical and semi-professional men in pioneering and process improvement programs. Seeking assignment offering good potential and requiring combination of engineering competence and good human relations approach. Box 10-11.

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ACADEMIC POSITION—Chemical Engineering. Teaching experience in thermodynamics, transfer operations, heat transfer and other Ch.E. subjects. Graduate and undergraduate. Ph.D. Research and industrial experience. Publications. Box 12-11.

CHEMICAL ENGINEER — B.Ch.E., registered, age 40. Twelve years' experience in process development, start-ups, troubleshooting, manager technical service. Principally inorganic. Desire position in similar work with greater challenge. Box 13-11.

CHEMICAL ENGINEER—Ch.E. degree. Age 31. Single. Seven years' varied experience in plant engineering, quality control, supervision, and process development. Desire position in Los Angeles in production supervision or process development. Box 14-11.

CHEMICAL ENGINEER—Eighteen years' diversified experience in research and development, plant engineering and production management for petroleum, chemical and nuclear industries. Desire responsible position in East. Box 15-11.

CHEMICAL ENGINEER—B.Ch.E., five years' process engineering experience with petroleum refining including process design, control, and economic evaluation, and two years' process development experience with vinyl polymers. Request responsible position with domestic or overseas organization. Box 16-11.

CHEMICAL ENGINEER—B.Ch.E., 1955, age 28, married. Three varied experience chemical industry; two and one-half years' technical writing, administrative work aerospace industry. Desire development or production opportunity in chemical industry. Prefer East or Midwest. Box 17-11.

CHEMICAL ENGINEER—B.S.Ch.E. Age 34. Ten years' experience in technical sales, service, and sales promotion. Extensive knowledge of water treatment, corrosion, and aluminum metallurgy. Seeking responsibility and opportunity with growing company. Will relocate. Box 18-11.

CHEMICAL ENGINEER — B.S. Twelve years' diversified experience applied research, engineering, technical service, quality control. Inorganic fields. Practical and business minded. Accept responsible and remunerative job only. Prefer Midwest or Midsouth. Box 19-11.

CHEMICAL ENGINEER—B.Ch.E., 1948, over twelve years' experience in rubber fluorocarbons, wire and cable covering development, project engineering and technical service. Desire responsible position with progressive company in New York, New Jersey, Conn. area. Box 20-11.

CHEMICAL ENGINEER—B.S.Ch.E. 1949. M.S. Ch.E. 1954. Age 36, family. Varied experience in organics and fertilizers including pilot plant, development economics, process, and design. Supervision experience. Desire position with responsibility and advancement potential. Minimum salary $9,600. Box 21-11.

(continued on page 178)

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- **Control Engineer**—B.S. or higher degree with graduate study in control system theory, electronic analog computers, advanced electronics, random processes and noise, or advanced mathematics. Duties will consist of developing and testing control systems for chemical processes and evaluating analytical instruments and special-purpose computers. Analog computer experience desirable.

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SITUATIONS WANTED
A.I.Ch.E. Members

(continued from page 177)

CHEMICAL ENGINEER—CHEMIST — 45, B.S. Ch.Eng. 1940. Six years' graduate work petroleum engineering (five publications), electronics and nuclear engineering. Fifteen years' experience chemist, five years' experience development engineer. Gulf Coast or central Texas. $8,400 minimum. Box 22-11.

CHEMICAL ENGINEER—B.Ch.E., upper quarter of class. Twelve years' process engineer experience petroleum refining and textactive metallurgy. Primarily design and construction. Desire supervisory position. Location immaterial. Age 36. Box 23-11.

CHEMICAL ENGINEER—B.S.Ch.E., 1957. Age 25. Experience in petroleum economics and long-range scheduling using linear programming. Desire position with opportunity in petroleum, petrochemicals, or chemicals. Prefer Gulf Coast location. Box 24-11.

CHEMICAL ENGINEER—B.S.Ch.E., 1958. Age 28, family. Two years' process design, process development, some pilot plant experience. Desire challenging position in chemical or related industry. Box 25-11.

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PICKLING LINE SUPERVISOR with chemical or metallurgical engineering training and at least 8 years' steel processing experience including coil pickling. Spanish desirable. Salary $12,000-$13,000 a year. Location, South America. P-9725.

INSTRUMENTATION ENGINEERS with a minimum of three years' experience in preparing, selecting and calculations on instrument systems for chemical process plant operation and design. Salary, from $8400 a year. Location, western Pennsylvania. W-9719.

CHEMICAL ENGINEER, young, to train for position as safety engineer for company dealing with organic and inorganic chemicals. Considerable traveling throughout the U. S. Salary, to start, $7500 a year. Present headquarters, New York, N. Y. but may relocate in Chicago. W-9714.

APPLICATION ENGINEERS, degree in engineering or science, chemical engineering preferred, with 2 to 5 years' experience in the application of process instruments, control valves or control systems. Will also consider experience in the application of other types of process equipment or in process engineering. Will provide engineering sales liaison in selling product; evaluate and recommend new product development programs, etc. Travel approximately 20%. Salary, $7000-$9500 a year. Company pays fee. Location, Pennsylvania. W-9683(a).

ENGINEERS. (a) Research and Development Engineer, graduate chemical or chemist, with advanced degree or equivalent in practical experience, to develop and apply new and improved materials and processes for diverse line of built-up mica and flexible electrical insulation products. Background in synthetic resins desirable. (b) Process Engineer, graduate chemical or chemist, to assume diversified assignments in the production of mica tapes, sheets and molded parts. Responsibilities will include maintenance of process specifications, insuring product quality and implementing transfer of new products from R & D to production. Must be familiar with natural and synthetic resins, molding techniques, and manufacturing processes involving hydraulic presses and treating equipment. Apply by letter giving complete details of experience, background and salary requirements. Location, Delaware. W-9662.

MANAGING DIRECTOR for a foreign subsidiary of a chemical manufacturing company. Duties would be those of a president of a 3 to 5 million dollar corporation. Responsibilities would include direction of production, purchasing, sales and finance. Location, Europe. P-9652.

SENIOR PROJECT ENGINEER, 30-42, chemical or mechanical graduate, with 5 to 10 years' experience in petro-chemical, refinery or chemical plant design, installations and equipment changes. Must be capable of handling project from initial inception to completion, including process calculations, layout, equipment selection, supervision of construction, cost control and start-up. Salary, $8000-$9000 a year. Location, Illinois. W-9648.

CHEMICAL ENGINEER OR METALLURGIST, advanced degree preferred but recent applicable experience most valuable. Should have experience in some of the following fields: High temperature metals and ceramics, joining of metals and ceramics, vacuum deposition of metals, combustion processes; for project involving conversion of heat to electricity. Salary open. Location, Connecticut. W-9625.

PROJECT ENGINEER, graduate chemical, with heavy chemical experience, to design and lay out ore processing equipment, steam power and heating facilities, plumbing and air conditioning. Salary, $8000-$10,000 a year. Location, eastern Pennsylvania. W-9598.

CHEMICAL OR MECHANICAL ENGINEER, graduate, with a minimum of 3 years' experience in process or mechanical design, preferably petroleum refinery or in related industry. Salary open. Location, Westchester County, N. Y. with possible overseas assignment. W-9524.

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PATENT ATTORNEY, LLB with B.S. in chemical engineering or, chemistry, with 3 to 5 years' experience in patent solicitation, to work as chemical patent attorney. Patent examining experience in U. S. Patent Office desirable. Will not consider a trainee. Salary, $10,000-$15,000 a year. Company pays fee and relocation expenses. Location, Connecticut. W-9434.

PAPER TECHNICAL SERVICE ENGINEER, graduate chemical, for laboratory and customer service assignment. Five to 10 years' experience in paper or paper chemistry. Salary, $9400-$9600 a year plus or minus. Location, northern N. J. W-9390(a).

EQUIPMENT CHEMICAL ENGINEER, B.Ch.E., B.M.E. or equivalent, with at least 3 years' experience in position related to process equipment design, evaluation or selection, with either vendor or user. Duties will include application engineering or process equipment, product engineering and development, sales coordination and planning, some technical sales calls. Salary commensurate with experience. Location, Rhode Island. W-9386.

CHEMICAL ENGINEER with process equipment plant experience for safety engineering work (valves, pumps—petro-chemical processing). Salary, $11,000-$12,000 a year. Location, Texas. W-9384.

CHEMICAL ENGINEERS AND CHEMISTS for research. Desire research proven organic or physical organic men to work in areas of papermaking resin synthesis, wax and polymer coatings, new products research, pulping, new processes for raw materials source, waste-product research and high polymer research. Salaries open. Location, Pennsylvania. W-9370.

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DEVELOPMENT ENGINEER, graduate chemical, for mechanical equipment development for company manufacturing glass tubing, rods, press and molded, as used in chemical laboratories. Recent graduates considered. Salary, $6500-$7200 a year. Location, southern N. J. W-9352.

HEAT TRANSFER DEVELOPMENT ENGINEER, 27-35, preferably M.S. in chemical or mechanical engineering, but will consider B.S., with approximately 5 years' experience in analytical heat transfer engineering, for development of improved heat transfer surfaces for heating, refrigeration, air conditioning and process applications. Must have well rounded background in the theory of heat transfer and fluid flow. Salary, to $10,000 a year. Location, Midwest W-9344.

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PROJECT ENGINEER, graduate chemical, ceramic or metallurgical, for a manufacturer of insulation and building products, with 5 years' research experience in related industry, for product development work. Salary, from $9000 a year. Excellent opportunity. Location, Central New Jersey. W-9282.

PATENT LIAISON ENGINEER, mechanical or chemical graduate, to prepare technical information for patent and trademark applications; review research reports; handle all correspondence, provide assistance and information to research and development and production departments related to patents. Must be able to write technical descriptions. Salary, $7000-$9000 a year. Location, New York State. W-9250.

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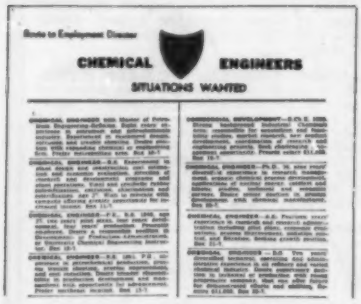
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CHEMICAL ENGINEERS

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News and Notes of A.I.Ch.E.

Professional development

Some members of A.I.Ch.E. are probably not fully aware of the interest the A.I.Ch.E. has in professional development. This does not mean that it is interested in salaries and salaries alone, or in licensing and licensing alone, or any of the single indications of a profession. The philosophy of A.I.Ch.E. has always been that a chemical engineer must develop as a whole professional man. This has been indicated in the pamphlet *Professional Standards* (we have distributed over 30,000 of these), in the Institute's statement on registration, and in all the activities of our professional program. We believe that sporadic activities designed to capture the public's imagination on the importance of engineering are not wise unless they are combined with a realization that professsional development encompasses a man's attitude of mind as well as his ethics. In the words of a former A.I.Ch.E. president, "the respect of others for the profession of chemical engineering can only be commanded, it cannot be demanded." In line with that philosophy, for some years the A.I.Ch.E. has quietly been working with executives in the chemical process industries to try to convey to the industry the responsibilities that a professional man has to his employer and, more importantly, the responsibilities that an employer has to a professional employee. This is well explained in the pamphlet *Professional Standards*. Should any individual member of A.I.Ch.E. be interested in the techniques used, he has a standing invitation from every member of Council to inquire about them. I think that you will be pleasantly thrilled with the story that A.I.Ch.E. has developed on the meaning of being a professional!

Other reports in the professional area were presented to the Council: one of them, by Hank Nolting of Standard Oil of Indiana, is not quite ready for publicity purposes but will be shortly. Other things that Council has been discussing for several meetings, but which it is not yet ready to implement, concern a new Model Law for the registration of engineers, a report on several possible research projects from the Research Committee chairman, Karl Hachmuth of Phillips, and a special Ad Hoc Committee of the Sections Activities Committee by John J. Healy, Jr. There were also some intersociety matters concerning Engineers Joint Council and Engineers' Council for Professional Development. All in all it was a pleasing meeting, and as Secretary of the A.I.Ch.E. I came away from this Council meeting feeling that we had had an unusual opportunity to calmly view a broad vista of the professional picture.

Personal observations

Pardon me while I get out my soap box. The rest of this column concerns membership and some of the problems that face A.I.Ch.E. and the stalwart band in your Local Sections which is trying to carry out the ideals of a professional group through enlisting as many members as possible. This year has been a record-breaker as far as the number of new members in A.I.Ch.E. is concerned. Such an achievement is very fine, and the entire Institute should be grateful to each one of the members on this committee.

But this message is really to you members who are not inclined to get excited about a membership campaign. This year every copy of the Annual Report will have in it an application blank for your use in getting a new member. Irv Leibson, chairman of the Membership Committee, recently made a survey of Institute

Local Sections and found that about 4,500 chemical engineers are members of Local Sections but not members of A.I.Ch.E. He also found that there were roughly 3,000 in this same category in 1957. Furthermore, estimates by the Local Sections indicate that there are additional engineers in their areas who are eligible for Institute membership. It is important that we get all these people into A.I.Ch.E.

Last month I was invited to speak before the XXXII International Congress of Industrial Chemistry in Barcelona, and one of the points I made about chemical engineering in the United States was that a major problem is our really weak professional organization. The reasons for this are manifold—one being that persons who are trained as chemical engineers do not retain a great loyalty to the professional organization but become industry-conscious: interest in their industry takes the place of professional interest. This means that many good chemical engineers support industry organizations and neglect to support the literature, meetings, and other services of A.I.Ch.E. It is not only the Secretary of the A.I.Ch.E. who sees it this way. Among the material that came over my desk recently was an article that reminded me of Robert Burns's wail: "O wad some Power the giftie gie us to see oursels as ithers see us." This was an item in the Research Engineering Professional Employees Association *Bulletin* of the Standard Oil Company of Indiana which had this to say about the A.I.Ch.E.:

"A discouraging statistic came forth recently, discouraging that is, considering the hue and cry about professionalism and society status. A.I.Ch.E. membership stands at about 22,500, including the 3,500 or so Student Members. Considering there are about 60,000 eligible chemical engineers in the U. S., it is obvious not even a majority are members. If this is representative of the other societies representing scientists and engineers it becomes readily understandable why these same engineers and scientists do not enjoy the position held by doctors and lawyers. To have an effective organization like the AMA or the ABA working for you requires your support, both financial and personal.

"The many prominent engineers and scientists who have put forth their ideas on professionalism all believe the use of one's talents to benefit society is the prime criterion for professionalism. If these talents aren't even used for the benefit of their own professional society what then can be expected from their efforts toward society?

"Provide yourself with a voice in the affairs of your society. But don't just join, become active. Progress requires effort." F.J.V.A.

how to choose the right colorimetric analyzer

CRITICAL process decisions must often wait hours upon the result of a trip to the laboratory for a wet analysis. But for those determinations that can be performed colorimetrically, continuous, automatic endpoint analysis can now be performed right on the plant floor. New Milton Roy instruments continuously run through every step of a wet analysis in the parts-per-million—even parts-per-billion range without supervision. And any colorimetric analysis that fits these basic requirements can be automated:

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Standard designs include a built-in limit alarm and circular or strip chart recorder with single or multiple recorders. As many as eight different samples can be sequenced through a single analyzer, with the analysis of each recorded on an eight-point strip chart recorder. Individually adjustable limit alarms are also available for each of the multiple samples.

Write for Bulletin 1156-1

When to use the Chemalyzer* analyzer

The Chemalyzer unit is designed for simple colorimetric analyses requiring a single reagent, such as water hardness, residual chlorine and phosphates. A simple inexpensive unit, it has no reference cell, and therefore requires samples free of turbidity and discoloration. Though there is no amplification of the measurement signal, concentrations of impurities are detectable to the parts per million range.

One typical application for Chemalyzer instruments is monitoring effluent from zeolite softeners for hardness. At three or six minute intervals (as specified) a fresh sample of effluent is analyzed, and the ppm concentration of hardness is indicated on the face of the instrument. An optional feature is a high limit relay and switch to energize a red light whenever hardness concentration exceeds a pre-set limit. If recording is desired, a standard millivoltmeter can be quickly wired to recorder terminals located inside the analyzer cabinet.

The Chemalyzer is compact, easy to operate, and can be installed in minutes. It operates practically maintenance-free. All parts in contact with reagents are made of suitable corrosion resistant materials.

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How to control with Milton Roy analyzers

The high limit switch available in either instrument can be used to initiate control action directly or through relays. Typical functions include starting or stopping a controlled volume pump and starting an automatic regeneration cycle on a zeolite softener. Through the use of a proportional slidewire in the recorder, the Quantichem analyzer can automatically vary the capacity of a controlled volume pump, to increase or decrease the amount of chemical needed by the process.

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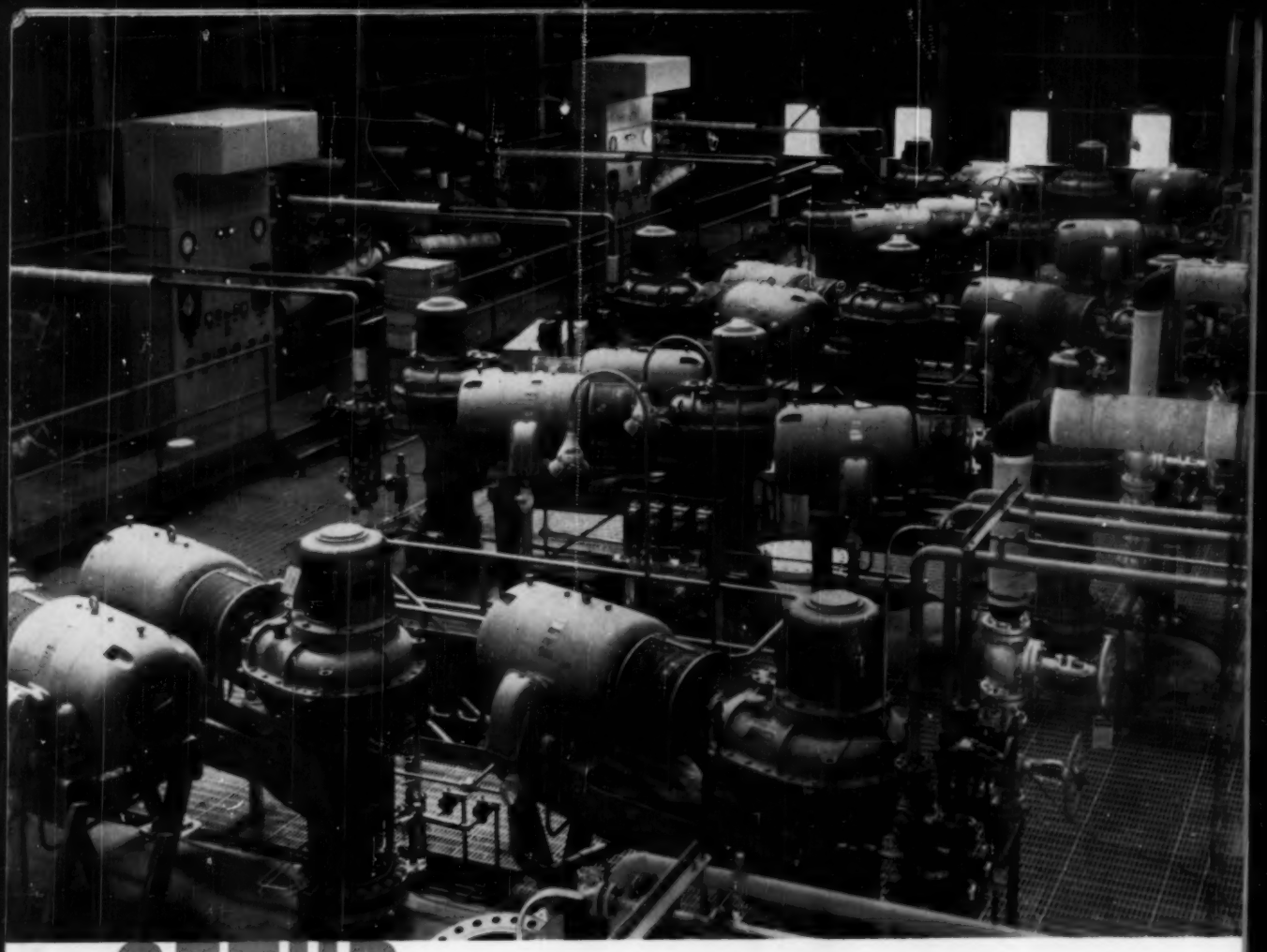

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